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ADAPTATION FUTURES 2016

practices and solutions



SCIENCE ABSTRACTS



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ADAPTATION FUTURES 2016 – THE SCIENCE CHAPTER





Climate change is one of the century's biggest challenges. People are confronted with the consequences of sea level rise, of increasing heat in the cities, of droughts and of floods. To help people protect themselves, adaptation strategies are being developed, flood protection plans carried out, new water conservation and exploration techniques are invented and trees are planted in cities to decrease heat.

Adaptation to climate change is a challenge that cannot be solved by practitioners or scientists alone. They have to work together to find innovative solutions to problems that otherwise cannot be solved. Adaptation to climate change not only requires innovations in the technical field. It also challenges existing governance structures, financial arrangements, decision-making processes and laws. Scientists and practitioners from different fields of knowledge and expertise need to cooperate.

Adaptation Futures 2016 offers a platform where scientists and practitioners from over 100 countries and many disciplines will meet and discuss new scientific results, implementation challenges, tools and business cases for adaptation.

In the programme book you can find descriptions of more than 155 sessions. This abstract book contains summaries of the presentations in the science sessions. In June 2015 we sent out a call for science abstracts for oral presentations and posters. The result was almost thousand abstracts ranging over the seven themes and three cross-cutting issues selected by the conference's Steering Committee. A group of 56 scientists (conveners) assessed all these abstracts and approved 257 as oral presentations and 105 as poster presentations. They then proposed a programme for the science sessions, that was approved by the Science Advisory Committee and subsequently by the Steering Committee. In this book you find all the abstracts approved per theme and cross-cutting issue.

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THEMES

1. CITIES AND INFRASTRUCTURE





ABSSUB-626

SC 1.1 The relevance of cascading effects for adapting critical infrastructures to climate change

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Research question: Critical infrastructures are of special importance since failure or functional impairment can have immediate and high impacts on more sectors as well as to the whole society. Therefore their consideration is of high relevance for strategies focused on adaptation to climate change. Furthermore energy-, water supply-, communication- and transport-infrastructure are often closely linked to each other and failures can propagate. There is still an urgent need for research on how to identify and deal with these so called cascading effects when it comes to adapting critical infrastructures to climate change. This research question will be addressed focussing on the German energy and water infrastructure.

Methodology: Energy supply as well as water supply and wastewater treatment are central parts of critical infrastructures. Based on a synthesis (literature review) of the current knowledge regarding the possible impacts of climate change on the German energy and water sector, the paper analyses where critical interdependencies are likely to occur. Furthermore, it discusses how these cascading effects could be addressed while adapting critical infrastructures to climate change, and highlights practical implications both for companies and policy makers.

Findings: Interactions between critical infrastructures have become a growing phenomenon as they are not only a point of potential vulnerability but may also compound existing vulnerabilities and carry them across multiple infrastructure sectors, like water and energy. For example the transport of water itself is in most cases dependent on energy to pump water. Although it is to be expected that water will be accessed from longer distances to meet the public water needs, which will also increase the consumption of electricity. The dependency of water on electric power has already been underscored by power outages that threatened water services or actually did bring water production and wastewater treatment to a halt. On the other hand the energy sector depends on services from the water sector. For instance thermal power plants are controlled by the availability and temperature of cooling water. During heat waves water availability decreases in general and water temperature increases. The combination of both reduces the efficiency of the power production.

Significance for practical solutions: Adapting critical infrastructures to climate change in practice is a complex, highly context specific, multifaceted issue, especially when it comes to dealing with cascading effects. Therefore the paper is of relevance for practical solution in order to deal with current knowledge gaps regarding how infrastructural interdependencies operate and how procedures and policies might improve the adaptation to climate change. These results will be useful for companies operating in the energy and/or water sector as well as for designing and improving future regulations and institutional settings addressing the adaptation of critical infrastructures to climate change.



ABSSUB-1341

SC 1.1 Adapting long-lived infrastructure to uncertain climate change

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Research question: Generally, investment and adaptation of infrastructure are associated with high sunk costs, and current decisions shape sensitivity to climate change up to multiple decades into the future. How should long-lived infrastructure be adapted to ongoing and uncertain climate change? Shall it be designed more robustly if uncertainty increases, or shall economic live-times be reduced? One prime example is uncertainty about the negative effects on infrastructure from extreme weather events and slow-onset impacts. Design options include the type of material used for building roads, rail track, airports, bridges, water pipes, or electricity transmission lines.

Methodology: We develop a two-stage real options model of infrastructure investments with long life-time. We assume that a retrofit of technical design parameters is expensive, so that technical design decision for currently re-built infrastructure is irreversible to some degree. Derived mathematically, the results can be condensed to stylized facts.

Findings: We present theoretically sound rules of thumb for efficient infrastructure adaptation decision making. For some cases, we confirm the intuitive option to increase the robustness of infrastructure as a response to climate change. Although that might increase costs in the present, it will reduce losses in the future. A more robust technical design will also increase the life-time of the infrastructure. Yet, irreversible design together with uncertainty poses the decision problem of whether to over- or under-adapt. Economically speaking, this leads to an option value, so that abandoning the investment might be delayed. In contrast, a shorter life-time might enable more efficient rolling adjustments to transient change. In some cases, a less robust and shorter-lived infrastructure might be the more appropriate adaptation.

Significance for practical solutions: Decision rules for infrastructure adaptation under uncertainty are crucial for all investors in such assets, be they public or private. Also regulatory agencies that have oversight on privately operated infrastructure benefit from used-and-useful criteria to approve adaptation expenditures in a legitimate way. As much infrastructure tends to be very costly, our results have a high economic relevance.

ABSSUB-1348

SC 1.1 The impacts of global and regional change on the resilience of critical infrastructures

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Research question: How does global change influence the resilience of Critical Infrastructures to extreme events? How to assess the dynamics of vulnerability of people to Critical Infrastructure failure? These are two core questions addressed within the EU funded international research project INTACT. In the recent past,



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significant progress has been made regarding the understanding of risks and cascading risk of Critical Infrastructures (CI). However, less systematic research has been done on how global and regional change influence the various risks to CI as well as the vulnerability of people to CI failures. These blind spots are addressed within this presentation.

Methodology: The development of the new framework is based on an intensive document analysis and expert interviews regarding past failures of Critical Infrastructures due to extreme events in countries in Europe and North-America. In addition, the research encompasses the examination of various data sources available at the EU and EU-member state level as well as for selected NUTS 3 regions in order to be able to calculate and illustrate societal, technological and environmental trends that have a significant influence on the risks of CI.

Findings: Overall, an innovative framework concept is presented that serves as a heuristic. It underscores the need to undertake broader and more holistic assessments when dealing with Critical Infrastructure related risks and human vulnerability to the failure of Critical Infrastructure services. The new framework captures global and regional change through the identification of core societal, economic, technological and environmental trends that affect key determinants of risks and resilience, namely exposure, vulnerability, response capacities and hazard intensity. Within a second layer of the assessment, the framework also takes into account the influence of these global and regional trends on human vulnerability to critical infrastructure failure. For example, the trend towards an aging society (societal change) in central Europe increases the dependency of people on critical infrastructures services, particularly in terms of the functioning of the health care system. The findings also underscore that societal (socio-economic) and technological trends differ significantly between the selected case studies examined.

Significance for practical solutions: Policy makers and operators of CI are an intrinsic part of the study and the tensions between present risk assessments and potential changes in risk profiles due to global and regional change are recognized. While a high awareness exists that environmental change – namely climate change - will pose a new challenge to the resilience of Critical Infrastructures, it is less evident for other dimensions, such as demographic and technological change.

ABSSUB-1290

SC 1.1 Simulated adaptation in storm water systems: evaluating the efficiency of adaptation pathways

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Research question: Storm water systems are a ubiquitous element of infrastructure around the world and are at risk to variation in the intensity, duration and frequency of extreme precipitation events. These systems are made up of individual units with varying characteristics. Replacement specifications for individual units are often specified by governing agencies, therefore we assume much of the adaptation will take place at the system level. We use the concept of adaptation pathways to look at the effects of replacement decisions on a system of culverts experiencing different patterns of climate change. Simulations reported here address:

1. How replacement pathways interact with climate scenarios and how robust replacement strategies are to a range of future climates.
2. The relationship between the potential cost for a pathway and the potential for regret.



Methodology: A simulation testbed of culverts allows us to look at both system and individual outcomes across an array of climate scenarios and replacement pathways. Simulations use Monte Carlo methods and take place over 100 and 200 years in order to include the full lifecycle of all units. Culverts in a system vary in size, material, lifespan, and design storm. We model climate as a change in the frequency of exceedance events. Because of the uncertainty associated with projected effects of climate change on extreme events we use a scenario approach for simulation. We use a bottom approach to climate scenario, including: (1) high, (2) medium, (3) low and (4) no change scenarios. Risk of extreme events increases along a linear trend with a random variable added to each year to simulate natural variability. Infrastructure replacement pathways implemented include: (1) replacement as usual, (2) upsize after extreme events, (3) upsize at time of first replacement, (4) upsize before the end of useful life, and (4) apply life extension to delay replacement. Cost includes normal replacement/maintenance, flood damage, and user delay cost.

Findings: Findings for a realistic system of culverts on the Colorado Front Range include: tipping points for pathways under different climate scenarios based on where they switch from cost-efficient to cost-inefficient compared to the current strategy. A sensitivity analysis is used to compare the impact of increased flood cost to the normal replacement and operating cost.

Significance for practical solutions: Pathways analysis help managers of dispersed systems assess the efficacy of adaptation strategies across a range of climate futures. Allowing managers to make better decisions about whether, how, and when to adapt under different climate uncertainty.

ABSSUB-1170

SC 1.1 A Pan - European framework for strengthening critical infrastructure resilience to climate change

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Research question: As European Infrastructures have lifelines that span in decades, it is imperative to generate scientifically truthful and validated knowledge on the potential impacts of climate, as a viable pathway for making resilient infrastructures. Owing to the multiple time scales involved, the main policy objective, as underlined in the EU Adaptation Strategy to Climate Change, is to move towards infrastructure network(s) that is resilient to today's natural hazards and prepared for the future changing climate. Furthermore, modern infrastructures are inherently interconnected and interdependent systems; thus extreme events are liable to lead to 'cascade failures'.

Methodology: EU-CIRCLE's scope is to derive an innovative framework for supporting the interconnected European Infrastructure's resilience to climate pressures. This will be based on the development of a validated Climate Infrastructure Resilience Platform (CIRP) that will: 1) assess potential impacts due to climate hazards, 2) provide monitoring through new resilience indicators and 3) support cost-efficient adaptation measures. The EU-CIRCLE framework, leveraging upon the vast amount of existing knowledge generated thus in the climate research, will provide an open-source web-based solution customizable to addressing community requirements, either in responding to short-term hazards and extreme weather events or in deriving the most effective long term adaptation measures. EU-CIRCLE shall devise a holistic framework for defining climate resilience into Europe's interconnected infrastructures, bridging multiple temporal and spatial scales. Short-term resilience and effective understanding and response to large scale extreme natural



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events, where safety and defence systems may fail and cliff-edge effects may appear, will be examined in a consistent framework to long-term adaptation policies and measures. This will be materialized through: (i) capacity to identify and withstand a shock from any hazard with no loss of critical functions, (ii) actions to prevent CI operation disruption from cascading into interconnected systems, (iii) maximization of business continuity, and (iv) adaptation to future risks through an advanced simulation capacity.

Findings: Is an overview of the EU-funded project under H2020 (GA 653824) "A pan - European framework for strengthening Critical Infrastructure resilience to climate change". As the project is still in its infancy, a generic abstract is submitted; the full paper will introduce up-to-date findings.

Significance for practical solutions: A core scope of EU-CIRCLE is to increase knowledge basis of infrastructure operators and national authorities alike. EU-CIRCLE will collectively allow for:

1. CI operators to familiarize themselves with critical event parameters with possible devastating impacts and domino effects,
2. Modelling impacts on the infrastructure operation, economy and society at-large
3. Collaborative preparedness in a region with CI "heterogeneous networks"
4. Promoting the collaboration of different operators

ABSSUB-1344

SC 1.2 Climate adaptation in spatial planning and the four big questions of what, where, how and who?

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Research question: Climate change and climate adaptation are asking for scientific, policy relevant and area specific research to explore impacts, make policy tracks, propose solutions, implement adaptation strategies and gain awareness. Moreover, climate change and climate adaptation are asking for cooperation and taking responsibilities at all governmental levels including civilians and other actors. This paper wants to find an answer to the what, where, how and who questions concerning climate adaptation in the Flemish region. What are the most relevant climate effects for the Flemish region? Where will the impact of climate effects be the largest? What are the possible adaptation strategies? Which measures can be taken to guard us against climate change? What are the boundary conditions for adaptation measures? How can the adaptation strategies be implemented in situ? How can research by design be used as a method in this field? In what way can or should the government deal with this threat/opportunity? Who are the other stakeholders and which role can civilians and private actors play?

Methodology: Over the past few years, the Flemish government ordered several spatial studies about climate change and climate adaptation in order to explore what can be done within the discipline of spatial planning to be ready for the future. The what, where, how and who answers will be obtained by bringing together and comparing the studies mentioned below.

The study 'Met ruimtelijk beleid naar een klimaatbestendig Vlaanderen' (translated: To a climate-proof region of Flanders with spatial policy) by Alterra Wageningen and Antea Group concluded in 2012 with advice for the Spatial Development Department Flanders about strategies to aim for a climate-proof region. With the study *Metropolitan Coastal Landscape 2100*, initiated in 2013 by Labo Ruimte (Spatial Development Department Flanders and Team Vlaamse Bouwmeester) and 3 other stakeholders, a long term perspective



for a sustainable coastal region has been obtained. The study was performed by the method of research by design. A large and intensive research was delivered in 2014 by the CcASPAR project. This interuniversity and interdisciplinary research aimed to answer questions about climate change and changes in spatial structures. The recently finished study '*Klimaatadaptatie en kwalitatieve en kwantitatieve richtlijnen voor de ruimtelijke inrichting van gebieden*' (translated: Climate adaptation and qualitative and quantitative guidelines for the spatial organisation of areas) by Technum is providing a working method for an adaptation policy and an overview of all possible adaptation measures.

Findings: /

Significance for practical solutions: /

ABSSUB-1047

SC 1.2 Key design parameters towards urban resilience - Insights into the transforming city of Tainan

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Research question: Laying in the subtropical Pacific, Taiwan is surrounded by rising sea level and extreme precipitation. As the earliest developed harbour of Taiwan, adaptability to flood has especially become the priority issue for the city of Tainan to transform into a resilient city. A wide range of related researches and strategies had been conducted. However, substantive practices and urban designs on enhancing adaptability to flood remain weak. Bridging the gap between science and practice requires involvement from executive decision makers and public participation. To accelerate collaboration on adaptation planning of professionals, decision makers and the public, this paper proposes a co-design online platform that fosters adaptation planning. The experiment of the co-design platform is conducted on the newest landscape proposal for a riverside square in Tainan's old city region. Eighty years ago, the location was one of Tainan's main traffic canals. However, after fifty years of sedimentation, the site was filled and covered with a shopping mall centre. Today, the site is going to be cleared out as a spare space to reconnect river water back into the old city region. Two parallel blue and green infrastructures are expected to be linked by this linear open space, a multifunction square featured with recreation activities, water resilient infrastructure and traditional settlement culture.

Methodology: Through procedural modelling technology, the platform offers a framework that each group of participants can engage in with order and efficiency. To this point, discussions between multi-parties can be started as different level of impact each proposal undergoes is distinguished. Under the consideration of applicable urban design elements for each site, key design parameters towards resilience are sorted out from those vibrant discussion contents. Quantization of these elements is scaled through comparison of climate impacts on environment and people between different proposals. As a result, each design proposal is examined with an adaptation score results from multi-parties' discussion.

Findings: Several key adaptation design parameters are identified through discussions within professional



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and practicing workshop, including set back distance of buildings, volume of rainfall runoff, building foundation height, diversity of land use types, percentage of open space on ground level, area of green and blue infrastructure and relative elevation of site to rising water level. All assessments are conducted and simulated through parameter control on the three-dimensional site model. Results are visualized and announced at the online platform, allowing discussion and adjustment to the proposal, making it a co-design progress.

Significance for practical solutions: What the study offers is a suggested framework for conducting a co-design adaptation planning. Evaluation criteria for resilience are the supporting structure of this framework, which are drawn from scaling of identified key design parameters.

ABSSUB-1178

SC 1.2 Co-creating climate change adaptation and resilience decision-making support tools with cities

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Research question: This abstract will present the innovative methodologies used in three EU-funded research projects, namely the RAMSES (FP7), RESIN (Horizon 2020) and Smart Mature Resilience (Horizon 2020) projects, to ensure that the research results produced by them are not only innovative and scientifically sound, but that they are also tailored to support European cities' policy-making on climate adaptation and resilience.

Methodology: Cities are highly threatened by climate change. As catastrophic weather events are set to become more and more frequent and intense, cities need to adapt to become more resilient to them. Nonetheless, often cities lack data, solid evidence and budget to invest in adaptation. The three aforementioned projects are taking innovative approaches in developing scientifically sound and policy relevant outcomes on urban adaptation. They include cities from the outset of their research endeavours, involving them in the testing and evaluation of the tools and products that they will ultimately create. The RAMSES Project (2012-2017), funded under the FP7 research programme, is developing much needed quantified evidence on the effects and costs of climate change in cities. RAMSES will provide the evidence basis that leads to reduced adaptation costs as well as better understanding and acceptance of adaptation measures in cities (<http://www.ramses-cities.eu/home/>). The RESIN Project (2015-2018), funded under the Horizon2020 programme, is investigating climate change adaptation practices in European cities and assessing impacts and vulnerabilities in order to develop standardised methodologies and decision support tools that cities can use to advance local adaptation strategies (<http://www.resin-cities.eu/>). The Smart Mature Resilience Project (2015-2018) will develop and validate Resilience Management Guidelines for cities, focusing on different critical infrastructure security sectors, as well as climate change and social dynamics (website under development).

Findings: During its presentation, ICLEI, Local Governments for Sustainability, European Secretariat will not only illustrate the resources that are being produced by these projects and their relevance for adaptation and resilience policy-making in cities, but also and principally the innovative methodology used to work with cities and to respond to the present challenges in tailoring scientific knowledge to policy-making. This methodology includes a preliminary assessment of cities' needs and a continuous involvement of selected European cities



to test and validate research results and share lessons learned. This will in turn facilitate uptake and dissemination of project results amongst other cities in Europe and beyond.

Significance for practical solutions: This presentation will be relevant to researchers and practitioners, who will learn about innovative ways to cooperate with each other to make a positive impact on urban adaptation.

ABSSUB-786

SC 1.2 Lessons learned from touchtable based interactive adaptation support tool sessions around the world

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Research question: In this presentation we present the lessons we learned from developing and applying the Adaptation Support Tool (AST) and how it can support planning for resilient urban areas. Creating tools that are effective in supporting urban planning for climate resilient and attractive urban areas is a challenge. Urban planning for climate resilience requires many stakeholders, especially when aiming for blue-green solutions. We created the Adaptation Support Tool to support this process. Based on the Adaptation Support Tool we organised interactive sessions with stakeholder to create sets of different climate adaptation measures in for an urban design to reach a certain climate adaptation target.

Methodology: The AST is touchtable-based planning support system has been developed, tested and applied to create sets of adaptation measures for a more climate resilient urban environment. The AST has been constructed including a selection assistant for 62 potential climate adaptation measures. By selecting a measure and drawing the measure on the map effectiveness is estimated for parameters like effective storage, peak flow reduction, annual groundwater recharge, heat stress reduction, water quality effects, costs and benefits of each adaptation measure and of the total package of measures. We applied the Adaptation Support Tool during conceptual and preliminary design sessions for reconstructing or developing urban areas in Mozambique, US, UK and the Netherlands. The aim of the sessions was to create different sets of adaptation measures to meet a predefined adaptation target with all relevant stakeholders including citizens.

Findings: The interactive sessions were very effective to get different sets of measures to reach adaptation targets in most cases or show the physical constraints in others. A large part of the success is in the fact that stakeholders can immediately see the effect of the proposed measure, which contributes to a more clear discussion. Next to that the positions of the different stakeholders became very clear. As the tool is under continuous development we found out what kind of information is relevant in the discussion to come up to a successful design and which is not relevant, or even hampered the discussion. Also the way of presenting the effects and the level of detail in the models and results influenced the discussion.

Significance for practical solutions: The presentation gives insight in the added value of the touchtable-based interactive modelling tools like the Adaptation Support Tool in interactive planning sessions with multiple stakeholders. This is relevant to both tool developers and potential users of these tools.



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SC 1.3 Bridging adaptation to climate change across city scales in Kampala

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Research question: The fast-paced urbanisation climate change impacts have put the lives of urban populations especially the urban poor at high risk. Facing the reality of climate change impacts and coupled with the inherent development challenges, cities are also now considered as having a potential for solutions to adapt and mitigate climate change. There are currently few comprehensive examples of climate change adaptation that are scalable. Kampala faces many challenges but evidence from early initiatives indicates that dealing with such problems and challenges requires the active involvement of all stakeholders across spatial scales. This paper will discuss scalable adaptation for bridging local to city-wide linkages of adaptation measures.

Methodology: Adaptation measures have been evaluated as capital investment, capacity building and poverty alleviation strategies. A summary of the adaptation measures that were evaluated include; Innovative urban agriculture activities utilizing limited space and technologies in response to urban poverty; Urban greening on hill slopes to increase infiltration. Upslope techniques such as infiltration ponds, greening courtyards and increasing plot-level infiltration, multi-purpose water retention ponds down slope that can be utilized for fishing and irrigated high-value crop farming; Up scaling these innovations to city-wide level can be through knowledge sharing and review of urban development policy by preparing strategic spatial plans adapted to effects of climate change

Findings: Flooding which of recent has been exacerbated by climate changes, constitutes one of the major stressor to life and property. Flooding effects include; disease outbreaks, loss of property, loss of working hours, loss of business capital, loss of education hours/days for children and on some occasions loss of life. Adaptation actions have included transformation of organic waste to briquettes for fuel, compost for gardening and utilization in raw form where adapters have adopted crop-livestock systems. Utilizing space-confined technologies, sorting of peels is done manually and sun-dried and later processed for poultry feed to fill the gap created by the high cost of maize bran.

Significance for practical solutions: Knowledge is a key ingredient of the whole process of adaptation in the city region to enable understanding and response by society to climate change risks. It is recognized that a wealth of climate change knowledge exists but this knowledge is not widely disseminated or circulated which necessitates innovative ways of enabling information flow for up scaling and out scaling of innovations. A network through which information flows and ideas exchanged has been established with communities, decision makers, city managers, researchers and civil society actors dubbed Local Urban Knowledge Arena (LUKA) has been established to start an information flow system that will enable resources to be strategically deployed to key adaptations.



ABSSUB-579

SC 1.3 A reality check for urban resilience research

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Research question: What are the key directions that future research on urban resilience must follow in order to enhance the ability of cities in the global south to function and flourish in the face of climate extremes and disasters?

Methodology: This findings are derived from an extensive review of the urban resilience literature and empirical data from semi structured interviews. Key search terms were consistently applied in academic journal databases/indices to ensure that a comprehensive pool of literature was obtained. Exclusion criterion were developed and papers focusing on urban resilience in the context of society, ecology, SESs, climate change and disasters were retained. 40 articles were selected for review. Empirical data was gathered through semi-structured interviews with 66 policy makers/influencers from 13 cities in seven countries (Bangladesh, China, India, Indonesia, Pakistan, the Philippines and Vietnam). Overall, the insights derived through literature were tested against empirical data to yield clear insights on the direction that research on urban resilience needs to take.

Findings: The body of academic literature on urban resilience argues urban resilience is contingent upon decentralised decision-making, structured learning, engaging concurrently with multiple shocks and stresses, getting urban planning right and understanding the political underpinnings of risk and vulnerability. Yet, interviews with policy makers in 13 cities in developing countries reveals the need for researchers to engage with the relationship between decentralisation and resilience more critically, explore the value of informal learning processes, avoid conflating shocks and stresses, acknowledge the limits of urban planning as an entry point for resilience and lay greater emphasis on the interaction of politics and resilience.

Significance for practical solutions: Urban resilience is a fledgling domain of knowledge and the findings of this study will help establish the future directions that research in this domain must follow. This in turn will help in the formulation of appropriate responses to enhance the ability of cities in the global south to function and flourish in the face of climate extremes and disasters.

More specifically, the findings call for research that-

- Critically analyses current assumptions on greater decentralisation resulting in enhanced resilience
- Looks at the type of 'learning' that would support urban resilience in the global south.
- Acknowledges the limited impact of urban planning to highlight alternative routes to enhancing resilience (such as working with the informal sector).
- Stops conflating 'shocks and stresses' as each is thought of very differently by those running cities.
- Further emphasise the political nature of risk and vulnerability.
- Draws in empirical data from cities in developing countries.



ABSSUB-1418

SC 1.3 Urban vulnerability assessment to climate change in the Concepción Metropolitan Area, Chile

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Research question: There is a growing number of urban vulnerability studies, but few of them quantitatively assess the enabling conditions to develop the process of adaptation. This paper assesses the vulnerability for the nine municipalities of the Concepción Metropolitan Area (CMA) in Chile. This research is the first to track in Chile the temporal and spatial distribution of vulnerability in the recent past (for 1992 and 2002) through a fuzzy overlay approach with Geographic Information Systems (GIS). This research seeks to answer the following questions:

1. What was the level of vulnerability of CMA in 1992 and 2002?
2. How did the level of vulnerability change between municipalities in CMA from 1992 to 2002?
3. Which vulnerability components (i.e. exposition, sensitivity and adaptive capacity) are the most influential in the level of vulnerability of the CMA' municipalities?

Methodology: Fuzzy logic modelling within ArcGIS software was used to generate and spatially map an urban vulnerability index for the nine municipalities in CMA. The model is based on a set of indicators of exposure, sensitivity and adaptive capacity, which were standardised and then aggregated through a stepwise approach into the index. To understand preconditions for planned adaptation, two indices were built: one applied for 1992 and another one for 2002, thus, covering the changes in the indicators over a period of 10 years.

Findings: The resulting vulnerability index was useful for identifying, understanding and tracking the spatial patterns of the CMA's' vulnerability. Fuzzy modelling has a high flexibility in the data aggregation process, combining different fuzzy membership functions and testing different fuzzy overlay functions. The structure of the index into three components, exposure, sensitivity and adaptive capacity, allows a simple examination of the various components in relation to each other. This type of analysis is important because it emphasises the differences that can be seen in urban areas such as the CMA where there are significant local variations, which are clearly shown by the components, demonstrating that this design eases communication of the results.

Significance for practical solutions: The resulting vulnerability index can help identify municipalities where the exposure, and sensitivity are high, and the adaptive capacity is weak and identify which components of vulnerability need strengthening. Identification of these conditions can stimulate dialogue amongst policymakers and stakeholders regarding how to manage urban areas and how to prioritise resources for urban development in ways that can also improve adaptive capacity and thus reduce vulnerability to climate change. The index results contribute to the understanding of the preconditions for planned adaptation, i.e. "situational analysis", the first step in the planning process for climate change in cities.



ABSSUB-880

SC 1.3 Working with local actors on ecosystem-based adaptation of vulnerable delta-city Beira, Mozambique

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Research question: Key-objective of the Dutch GreenInfra4Beira project (2014-2015) was to enable local stakeholders in the delta-city of Beira (2nd city of Mozambique) to solve their storm water problems using green infrastructure as solution. During heavy rains large parts of the city are frequently being flooded due to a lack of proper storm water management. This flooding has serious health impacts for the 0.5 million residents and obstructs further urban and economic development of the city. Project developers, who recognize the city's potential to grow significantly, hesitate to invest because of poor estate development conditions. The city lacks capital to deal with storm water in a regular civil engineering way (e.g. extensive sewer systems). Urban green, which is widely present in Beira, may increase the water retention capacity of the city, reduce soil erosion and provides other benefits like food production.

Methodology: A Dutch consortium of water, ecosystem, engineering and urban design experts (research institutes Deltares and Alterra, Witteveen & Bos, Wissing urban design, Floodconsult) have introduced an Ecosystem-based Adaptation (EbA) approach for the city's storm water management to the local actors in Beira. This new approach identifies opportunities to better utilize the urban green for urban climate adaptation, linked with the existing water management system and with the current demands for urban green (food, shelter etc.). Sophisticated scientific tools (the evidence-based Adaptation Support Tool, AST), empirical field research (soil, water, vegetation) as well as stakeholder process techniques including landscape design workshops have been used to enable the civil servants and citizens to better cope with the storm water issues. The approach is applied for the residential poor neighbourhood of Chota (7.5 km²) and adjacent rural area where a lagoon (100 ha) is proposed.

Findings: In a series of workshops and field visits with local stakeholders (municipality and citizens of Beira, Universidade Católica de Moçambique, private investors), the following results have been achieved:

- i) identification of cost-effective blue-green measures that fits local culture, and locations in Chota where these measures can be applied,
- ii) a sketch EbA design for Chota calculated by the AST tool for its contribution to demanded water retention capacity,
- iii) development of the Lagoon-concept that could support the necessary water retention capacity additional to the EbA-plan for Chota,
- iv) sketch design of the Lagoon including new areas for residential, resort and wildlife habitat development,
- v) business case calculations for implementation of the Lagoon development.

Significance for practical solutions: In September 2015 a finance congress has taken place in Beira in which numerous (inter)national governments and NGOs have welcomed the outcome of the GreenInfra4Beira and other projects to substantially improve living conditions in Beira and have promised substantial funding for their implementation.



ABSSUB-701

SC 1.4 The role of urban green infrastructure measures in improving outdoor thermal comfort

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Research question: Cities are expected to experience heat days in summer more frequently and with higher intensity due to climate change. Urban green infrastructure can help cities to adapt to climate change by providing regulating ecosystem services. Therefore, municipal planning should foster policies and activities for so-called ecosystem-based adaptation. However, municipalities need to be supported by more information and better guidance as to the extent and type of green infrastructure measures they should implement.

Methodology: Against this background, this study aims to increase our understanding of the regulating effects of different green infrastructure settings under a future climate change scenario. Based on a scenario modelling approach, we assess the cooling potential of green roofs, green facades and tree plantings during hot summer days for varying green volume as well as current and future climate conditions. The research applies the urban microclimate model ENVI-met for a case study located in the city centre of Munich, Germany, representing a typical urban fabric of perimeter blocks, which is commonly found in both German and European cities. We analysed the effects of greening interventions on reducing air temperatures and outdoor thermal comfort (PET – physiological equivalent temperature) in a densely built urban area.

Findings: The results show which greening measure has the highest potential to regulate the urban microclimate during day and night time as well as today and in the future. Thereof, we concluded how much greening needs to be implemented to effectively mitigate climate change impacts and increase outdoor thermal comfort conditions.

Significance for practical solutions: Following from this, a guideline for urban planners is developed, supporting them in choosing the most effective combination of green infrastructure measures suitable for their respective situation.

ABSSUB-798

SC 1.4 Low carbon options for adapting heating and cooling of dwellings in 29 Portuguese municipalities

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Research question: Approximately 72% of the European Union (EU) population lives in urban environments¹. Cities are acknowledged as major players in fighting climate change by reducing greenhouse gases emissions (GHG)², as energy consumption in EU buildings is responsible for about 40% of total final energy use and 36% of CO₂ emissions³. Much of this energy is used for heating and cooling, ensuring the thermal comfort and health of its occupants. Expected changes in temperature, including extreme weather events as heat waves,



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will increase the impact on public health. Thus, cities and regional authorities are increasingly preparing adaptation strategies for such situations, including increasing energy use to keep levels of thermal comfort, which may counteract mitigation efforts. How can households' comfort become climate resilient without compromising mitigation targets?

Methodology: We developed a methodology to assess the vulnerability of residential dwellings to climate change regarding thermal comfort and to quantify the benefits and emissions of adaptation options. This is implemented for 29 municipalities in Portugal within the Municipal Adaptation Strategies Project ClimAdaPT. Local. The methodology follows the approach described in (Fritzsche et al. 2014)⁴ addressing complementarily potential impacts and adaptive capacity. A simulator was developed to assess for the sub-city regions: (a) current and future impacts, adaptive capacity, and vulnerabilities, and (b) how adaptation options improve climate comfort without counteracting mitigation.

Findings: In our results we compare vulnerability across cities and identify priorities for adaptation measures without increasing GHG emissions. We cover varied climatic zones, building types and socio-economic contexts.

Significance for practical solutions: These results are currently being used by the municipalities' technicians to support city planners' evaluation of the current vulnerability of citizens, their causes and solutions, and in developing future scenarios depending on future climate, socio-economic conditions, deployment of heating and cooling technologies and building rehabilitation. The outcomes are of uttermost relevance for developing local adaptation strategies, especially regarding synergies with sustainable energy action plans including energy efficiency policies and measures.

- 1 http://ec.europa.eu/eurostat/statistics-explained/index.php/Statistics_on_European_cities
- 2 <http://unhabitat.org/urban-themes/climate-change/>
- 3 European Commission (2008). Energy efficiency: delivering the 20% target
- 4 Fritzsche K., Schneiderbauer S., Bubeck P., Kienberger S., Buth M., Zebisch M., Kahlenborn W.(2014). The Vulnerability Sourcebook - Concept and guidelines for standardised vulnerability assessments pp.177. GIZ GmbH, Adelphi, EURAC Research. Retrieved from: http://www.adelphi.de/files/uploads/andere/pdf/application/pdf/vulnerability_sourcebook_-_guidelines_for_assessments_-_giz_2014.pdf

ABSSUB-1328

SC 1.4 Housing adaptation measures to extreme heat for the urban poor in South Asia

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Research question: What low cost adaptation measures do the urban poor of South Asia have to make their houses more climate resilient?

Methodology: We measure indoor temperature in 180 resource poor households, which cannot afford air conditioners across three urban residential areas in Bangladesh, India and Pakistan with small data loggers. The loggers measure and store air temperature in fixed intervals of 10 minutes in houses constructed of



different building materials and different designs. We look at dissimilarities across houses to derive measures not yet done in such a fine detail before. The indoor measurements are also compared with outdoor temperature. In this manner we are able to depict an integrated view of the environment.

Findings: Different type of houses have different impacts on indoor air temperature, indicating options for improvements. The measurements show a variation of three °C during night time and five °C during day time across the sampled houses. In light of projected temperature increases in the future the effect of different housing types on indoor temperature is at the same time alarming and also promising.

Significance for practical solutions: Climate change is believed to be the greatest threat to human health in the 21st century. Costing more than 4.000 lives, the recent heat wave events in Pakistan and India showed the catastrophic consequences extreme temperature can have on humans, even in regions where one would expect people being accustomed to heat. Most epidemiological studies establishing a relation between health outcomes and extreme heat usually rely on meteorological data from standardised weather stations outside of city limits. These do not reflect well heat exposure in urban residential areas, where the majority of people live. People's vulnerability to heat depends on socio-economic factors, medical conditions, behaviour and risk awareness, but also on environmental determinants, such as housing type and outdoor landscape. A better understanding of varying heat exposure related to the environment would help design low-cost interventions in resource poor countries. In this study we analyse what kind of houses can support adaptation to rising temperatures in South Asia. Characteristics such as poverty, rapid urbanisation and extreme temperature make South Asia a hot spot for studying. A translation of the results from this study into guidelines on how to best design and construct houses and the correct implementation of these guidelines could lead to effective low cost adaptation measures for resource-poor urban habitants. Such measures in combination with smart spatial planning bear the potential to increase the resilience of rapidly expanding cities.

ABSSUB-1024

SC 1.4 Heat stress measurements in Amsterdam

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Research question: The main aim of this research is to investigate the outdoor thermal comfort situation in the public space of Amsterdam during hot days. The research questions are: What are the thermal conditions during extreme warm days in the city of Amsterdam? How are the thermal conditions perceived by the citizens and visitors of Amsterdam? And how does the thermal perception relate to the urban design?

Methodology: We used measurements from mobile weather stations (air temperature, relative humidity, wind speed, global radiation and globe temperature) and personal interviews with people in the urban environments as methods to answer the research questions.

Findings: During the summer of 2015 and its heat wave, we carried out heat measurements at 13 different locations in Amsterdam. To investigate the thermal situation for different urban environments, we measured at green locations (a.o. Vondel park and Museum square), impervious areas without any vegetation (a.o. Dam square and in front of Central Station), along or near water bodies ('t IJ and Amstel river), and in both sunny and shaded areas. We collected measurements over 7 summer days and in total, we conducted 971 interviews. The questionnaire used for the interviews included personal information (age, gender, activity, clothing, cultural background) and questions on thermal perception, thermal comfort and thermal preference. The



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analysis of the meteorological measurements and questionnaires give insights in which factors and which urban designs (green, water bodies, shade) lead to thermally comfortable places during warm days.

Significance for practical solutions: The results of this research are directly relevant for local professionals, (including those of the Municipality of Amsterdam), urban planners and decision makers, who want adapt the city to rising temperatures and extreme heat events. Many local governments struggle with this issue and need information on the right measures to adapt to rising temperatures and extreme temperature events. How do we keep the urban climate liveable and comfortable? How hot can it be in the city and how can we develop and design cities that are thermally comfortable also during very warm periods? More green spaces, urban vegetation and shading in the city can for example provide cooling. Trees and shade keep climate comfortable during hot days. To give answers to these questions, we have carried out this investigation. The findings give insights in which factors and which urban designs (with green, water bodies or shade) lead to thermally comfortable places during warm days. This information contributes in developing design guidelines to improve the urban climate during extreme temperature events.

This research had been carried out within the framework of the Dutch research project 'Urban climate resilience – Turning climate adaptation into practice'. The aim of this project is also to support urban professionals working with local spatial planning with turning climate adaptation into practice.



ABSSUB-1385

SC 1.5 New spaces of flows? Global urban networks in climate change adaptation

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Research question: Cities around the world are proposing ambitious urban plans to respond to climate impacts, promoting ecological security and the perpetuation of economic growth, while raising intractable social questions about spatial justice and equity. Scholarship on urban climate change adaptation planning has tended to reinforce static conceptualizations of the city as a bounded territory, neglecting interconnections across networks and broader processes of globalization, urbanisation, and geopolitics. This presentation explores global/urban networks in urban adaptation – the connections through which concepts travel, transform, and embed. I ask, in the face of climate change and globalized urban development, how are new actors, institutions, and networks emerging to mobilize ideas and influence across political boundaries and geographical scales?

Methodology: I investigate strategies in three cities, including Rebuild By Design in New York, the Giant Sea Wall plan in Jakarta, and Rotterdam Climate Proof. I focus on the roles of global networks such as Connecting Delta Cities, public-private partnerships such as Netherlands Water Partnership, national development programmes, and urban spatial plans. I develop a method of urban relational analysis to study disparate yet highly interconnected sites. On one level, this is a mixed methods study of multiple design strategies across different cities, combining semi-structured interviews with field and participant observation, and spatial and visual methods. On another, I build on frameworks for a more reflexive approach to case selection and analysis and a relational reading of sites – each understood through the others.

Findings: I find that global, national, and urban scales are increasingly intertwined, with new institutions and frameworks of connectivity – at various scales – creating links between policies, practices, and interventions through the range of urban and global scales. These interconnections form multiscale, multilevel networks through which ideas, influence, and capital flow. These networks are empowered – conferred further reach and influence – by colonial and postcolonial histories, the inherited conventions of global development, and, now, the imperatives of climate change. At the same time, I find that urban adaptation projects, while globally constituted, are reformatted by and to local urban sociospatial systems, and the production of alternative visions, “counterplans,” enables modes of organising and resistance to hegemonic systems.

Significance for practical solutions: These findings emphasize the agency of marginalized urban communities and the embeddedness of climate change responses within multiple scales and levels of global urban development. They imply that planners committed to just socio-environmental outcomes engage across the range of urban scales and networks, and learn from critical social and political imaginaries and practices.



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SC 1.5 Community-based adaptation in the United States: understanding why communities are taking action

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Research question: In this project, we explored the research question, How and why do communities take actions to reduce their vulnerability to climate risks?

Methodology: We designed our research through five analytical activities. Through a targeted literature review and an extensive series of thought leader interviews, we compiled a baseline of important community-based adaptation activities and issues. We then constructed an overarching analytical framework to guide observations. To ensure that project outputs would be useful for on-the-ground adaptation practitioners and grounded in the latest knowledge in the field, we engaged a team of external experts in climate change adaptation and related fields to provide input throughout the project and to critique each activity stream. We then conducted 17 case studies of vulnerability-reducing actions across a range of communities in the United States. Lastly, we used information and observations from the first four activity streams to critically assess the adaptation field and develop cross-case findings that allowed us to generate state-of-the-practice conclusions.

Findings: We developed a set of findings that illustrate commonalities and issues of interest across our 17 case studies. For example, we find that a wide variety of factors drove communities to address their vulnerability to climate risk. In nearly all of our cases, exposure to extreme or repeated climate events is a critical factor driving community action to reduce climate vulnerability. These extreme events can increase public awareness and engagement and galvanize support for actions that reduce climate vulnerability. We then discuss the implications of these findings on the current field of community-based climate adaptation and the trajectory of the field. For example, community leaders and adaptation practitioners can prepare messaging in advance of extreme or repeated climate events, putting them in a position to make headway on implementing adaptation actions immediately after a severe event. This is just one example of a finding from our study; the presentation will dive into the findings in more depth.

Significance for practical solutions: Over the last 10-15 years, the field and practice of climate adaptation has experienced a substantial increase in interest and activity. But this surge in activity has not resulted in a consolidation of experience or a synthesis of approaches within the arena of climate adaptation. This project provides a state-of-the-practice assessment of how and why communities take actions to reduce vulnerability to climate risks. We develop an in-depth, detailed, case-based view of community-based adaptation to advance the field by making cogent, evidence-based suggestions for how to accelerate and improve existing efforts. We hope this presentation will provide new and interesting information about community-based adaptation and insights that can move the practice of community-based adaptation constructively forward as we face the challenges of adapting to a changing climate.



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SC 1.5 Integrating green and social infrastructure for climate adaptation: case studies across two regions

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Research question: Our session objective: Report on and facilitate shared learning across two geographic regions (Caribbean and US Northeast), examining case studies of climate-adapted urban green infrastructure in each and how they can better inform future practice.

Presenters include Dr. Barbara Carby, University of West Indies; Dr. William Solecki, Hunter College USA; Dr. David Dodman, IIED; Dr. Paul Kirchner, University of Massachusetts Boston, and myself, Dr. Elisabeth Hamin of the University of Massachusetts, Amherst.

Methodology: Integrating green infrastructure into urban environments is based on social conditions – local goals, vulnerability, equity, and capacity. The SAGE (Sustainable Adaptive Gradients in the coastal Environment) network, a US-NSF funded project, has been bringing together researchers, practitioners, policy-makers, and academics from a wide variety of fields crossing policy, planning, engineering, and coastal sciences. Members come primarily from two regions, the US Northeast and the English-speaking Caribbean, and co-learning is the key goal of the project. In this panel five members of the network present research case studies on the ways that green infrastructure is being used to improve local climate adaptation in their area, and the social conditions and requirements that enable that green infrastructure. A shared case-study framework allows for comparisons across the cases, but each paper also focuses on specific topics, such as how the demographic dividend in Jamaica and St Lucia might influence the nature of capacity building; the sustainable adaptation of infrastructure central to coastal tourism in Jamaica; the role of non-structural interventions such as local planning, zoning and building codes in the award-winning resiliency design in Bridgeport Connecticut, the implications of on-going policy shifts in the New York City adaptation process, and the interface of collaboration and technical challenges in an economically challenged area of the Boston region. The long history of disaster and resiliency in the Caribbean and the increasing research knowledge and adaptation policy implementation in the US provides valuable learning opportunities for both geographies.

Findings: The findings vary across case studies. The case studies are as follows: two from Jamaica, one each from St. Lucia, New York City, East Boston, and Bridgeport Connecticut. Each of these integrates social and green infrastructure, but in different ways and with different results.

Target audience includes urban planners, disaster risk reduction professionals, coastal engineers, policymakers.

Significance for practical solutions: Our session's desired results/outcomes are to improve collaboration and co-learning across two different, but vulnerable, regions in the Caribbean and the US. Improved knowledge of the social basis of climate-adapted green infrastructure.



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SC 1.5 Achieving bottom-up adaptation through local planning policy at the development consent stage

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Research question: Policies on climate change adaptation should be driven top-down through government tiers, but when policy is absent, can climate change adaptation be achieved through local government planning at the property development scale? As a local authority, Pittwater Council (Sydney, Australia) is the main consent authority for private property development within its local government area. With its 25 km of foreshore, including 18km of Pacific coastline and steep catchments, the area is vulnerable to long duration and flash flooding, coastal erosion and wave inundation impacts. As climate change impacts on rainfall intensity and sea level rise, these existing hazards are expected to increase in severity across the area. Development controls that require adaptive built solutions as properties redevelop, is one way in which the council is building resilience to natural hazards in the absence of state and national policies on climate change adaptation.

Methodology: Pittwater Council requires development proposals that intensify developments to consider sea level rise and increased rainfall intensity projections as a result of climate change impacts. The relative effectiveness of this local planning policy approach is examined by reviewing the outcomes of development consents and refusals within the local government area that were required to address flooding, coastal erosion or foreshore inundation, and the specified climate change scenario. The review considered determinations by the council and more broadly by external consent authorities, including state planning assessment panels, regional planning review panels, and court determined legal appeals.

Findings: Local development controls requiring climate change adaptation through higher minimum floor levels were in most cases observed, when the measure could be readily incorporated into the built form. Reasons for non-compliance were on the grounds of limited accessibility, building height restrictions and short design life. Additional climate change adaptation measures included flood proofing, building setbacks, landscaping, structural systems, monitoring, and emergency response plans. With the few developments that proceeded with less than optimal adaptation solutions, the use of a distance-based (hazard presenting within a set distance of a building) and time-based triggers (allowing future updates of planning levels) were considered, however this was found to be complex to implement. Overall, development proposals could integrate climate change adaptation measures through development consents.

Significance for practical solutions: In the absence of consistent and strong policy from top-down on climate change, local policy for development planning activities can be used as a mechanism to incorporate climate change adaptation into development on a lot-scale. This can be achieved at the local level by smarter building designs such as property modifications and structural protective measures which can be replicated across local governments.





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SC 1.6 How can design contribute to climate adaptation? Analysis of an international design workshop

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Research question: The governance of any complex issue encounters multiple barriers. Yet, the governance of climate adaptation is characterized by additional barriers, unique to the adaptation challenge (Biesbroek et al. 2013). For example, there is a great tension between the long-term impacts of climate change and the short-term dynamics of politics and decision-making. Moreover, climate adaptation is confronted with a high degree of uncertainty, since climate projections accumulate modelling and socio-economic uncertainties. The adaptation-specific barriers emerge in various sectors, among which spatial planning and urban design. These fields are used to deal with so-called wicked problems. The complexities and uncertainties associated with climate change, however, pose by far the greatest challenges that planners have ever been asked to handle (Susskind 2007). So how can planners and designer encompass the barriers to climate adaptation? Which skills do these professionals provide and which tools should be developed?

Methodology: This paper analyses the international design workshop 'Shifting Climate, Reshaping Urban Landscapes'. The design workshop is a period of close cooperation between multiple designers and stakeholders. It is a particular type of focus group, tailored to the fields of design and planning (Scott 2011). In this design workshop participants of diverse backgrounds worked in small groups on design proposals for the Lommel and Overpelt. These municipalities in the North of Belgium will need to adapt a changing water availability; wetter winters and drier summers by the end of the 21st century. The participants were informed on the local adaptation and spatial other challenges by stakeholders. In addition, they were assisted by three international master designers; Henri Bava (Agence Ter), Florian Boer (De Urbanisten) and Cees van der Veeken (Lola landscape architects).

Findings: The research explores what barriers the participants of the design workshop have encountered and how they tried to encompass them. The paper zooms in on adaptation-specific barriers such as the gap in time perspective, the high dependency on scientific input and the high uncertainty. The research uncovers various strategies to deal with these barriers throughout the design process. For example, some participants scoped the local impacts through an energy intensive study of flood models. Other participants, however, rather employed historical maps and diagrams of the geophysical system.

Significance for practical solutions: In such way, the research offers insights on the skills designers may bring to the adaptation table. In addition, the research discusses the potential surplus and pitfalls of a design workshop to the development of a local climate adaptation strategy.



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SC 1.6 Rebuild by Design: implementation of green infrastructure for flood resiliency in Hoboken

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Research question: After the devastating impacts of Hurricane Sandy in 2012, the Rebuild by Design (RBD) competition was launched. It gathered international expertise for generating solutions to tackle resiliency challenges in the region through offering innovative designs and presenting novel approach to policy development. This paper aims in understanding the implications of a design competition such as RBD to enhancing urban water resilience.

Methodology: One of the 6 winning proposals is Resist, Delay, Store, Discharge: A Comprehensive Urban Water Strategy offering solutions for the flooding challenges in Hoboken. The Strategy integrates hard infrastructure to reduce storm surge impacts and stimulates green infrastructure (GI) as a part of future storm water management. The research presented aims to assess the strengths and weaknesses of the RBD approach for the context of Hoboken. A series of semi structured interviews with core urban water management stakeholders was organised followed by an extensive desk study on the local context and process of RBD.

Findings: The results indicate that RBD influenced Hoboken in two ways. Firstly, it offered a unique opportunity to improve the coastal defence by offering technical solutions and allocating funds for implementation. Secondly, it strengthened the already present initial momentum for solving the storm water flooding problem. The innovative nature of the proposal put more emphasis on GI as a part of the overall strategy. Thus, by introducing multifaceted designs it opened a window of opportunity to solve additional issues experienced in Hoboken (e.g. lack of open space, environmental impacts of combined sewer overflows) rather than just flooding. However, the allocation of the funds received as an outcome of winning RBD only for the implementation of the coastal defence, indicates that GI implementation was influenced mainly through enhanced planning and creation of the long term vision. RBD created a strong local political buy-in seen as a crucial enabling factor for the implementation. However, the competition did not eliminate various barriers to implementation identified by core stakeholders and categorized as: technical, physical, financial, institutional, legal and regulatory.

Significance for practical solutions: Using a design competition as an instrument to answer challenges of an uncertain future for urban areas and catalyse the transformation of the whole region is a novel approach. It attracts professional capital, involves the community and shapes the creative process in which issues are identified and innovative solutions created. RBD improved the storm water management planning in Hoboken, set the scene for GI and gave a sense of direction to local decision makers. This brought worldwide recognition to Hoboken, making it one of the UNISDR Role Model Cities for its flood resiliency efforts. RBD created an image of Hoboken as the frontrunner in sustainable urban water management planning, thus making it a valuable learning case for cities facing similar challenges.



ABSSUB-723

SC 1.6 Design of floating developments based on ecology and living systems principles

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Research question: Floating settlements are often presented as an innovative option for coping with sea level rise and climate change. Floating productive developments in particular have been recently proposed as a solution to help reducing global land shortage. Challenges that land cities are facing, such as reducing energy and resources consumption, closing water and material cycles, increasing resilience and preserve biodiversity, are currently addressed while designing new developments or changing performances of existing ones. As a new development type, floating settlements are required to respond to those challenges, from the beginning. New paradigms that propose whole systems mental models have recently emerged with the objective to not only improve efficiency of buildings and cities but also to “*restore and regenerate the social and ecological systems*”. According to P. Mang and B. Reed, mutual benefits can arise from re-established relationships between humans and nature, which will help supporting their co-evolution and sustaining their health. The research questions addressed by this paper are the following: how can principles inspired by living systems contribute creating floating living environments that are mutually beneficial for humans and other life forms? How can findings from recent research that attempts to integrate humans into ecology be used to define a set of patterns for the design of ‘regenerative’ floating developments?

Methodology: In this paper, holistic principles and approaches inspired by living systems are summarized. The hypothesis is that living systems approaches can support the transition to more sustainable and ultimately ‘regenerative’ developments. Principles extracted from living systems and relevant literature on (urban) ecology is used to develop patterns that can be used in the design of future floating developments. Patterns are defined as “a three-part rule, which expresses a relation between a certain context, a problem, and a solution”. They are configurations of relationships and incorporate information about previously successful solutions.

Findings: The study shows opportunities to improve the performances of urban developments from an ecological perspective. Landscape elements as floating gardens and wetlands can contribute to increase ecosystem services in floating developments. Ecologically engineered systems and processes can help recycling and reusing resources as nutrients and water within floating developments, offering at the same time functions as production, research and education. Multifunctional landscapes designed to serve economic, social and environmental functions will bring financial and health benefits, both for communities and the environment.

Significance for practical solutions: The patterns for floating urban developments developed in this study of living systems provide input for the design of ecologically sound floating developments. Moreover they will also offer strategies for adaptation of urban development that takes into account the planetary limits.



ABSSUB-1316

SC 1.6 How can green infrastructure serve as adaptation option in low land areas? Case study: Makassar City

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Research question: Makassar City is one of the flood prone areas in West coast of Sulawesi Island. Based on previous study, flood occurred in low land areas that has the elevation of 1-4 m above sea level such as Tamalanrea, Tallo, Bontoala, Mariso, Makassar, Panakkukang and Rappocini Subdistrict. Increased built-up area in the reclamation and low land area coupled with high intensity of rainfall and land subsidence and bad drainage system are the causes that contribute to the flood in Makassar City. Thus, there are several key drivers related to the increased built-up areas as response to economic growth in the city that increased disaster and climate risks in Makassar City. First, the development along Tallo and Jeneberang Riverbanks could disrupt the river function as the catchment area and flood control. It also increases the sedimentation rate in the downstream area. Second, the development of CPI in southern coast on reclaimed land that can increase the risks of flood and seawater intrusion. Moreover, the area itself is prone to sea level rise impact. Unfortunately, there has been no significant measures provided by the government and also in disaster mitigation plan. In this study, we propose the potentials of Green Infrastructure concept in mitigating flood risk by utilizing the low land areas in Makassar as an example. The main objective of this paper is to analyse the opportunity of integration between green infrastructure and flood mitigation infrastructure.

Methodology: The analysis is conducted through descriptive analysis and GIS based spatial analysis as support in proposing mitigation scenario. We also involve the scenario of increasing sea level rise by recent study to provide more realistic scenario.

Findings: Based on the analysis, it is known that green infrastructure has the potential to be incorporated into flood mitigation measure due to its benefit in reducing run-off and storing rainwater.

Significance for practical solutions: All in all, green infrastructure can also serve to mitigate the flood in Makassar City, however other measures are also needed to maximize the benefit. Therefore, we propose that Makassar City needs to limit the development in the low land areas. Next, clear and well-defined elevation standard of the infrastructure and reclamation areas is required to ensure the connectivity of drainage system from the mainland to the low land. Other measures are to ensure the continuity of river normalization of the three main rivers (Jeneberang, Tallo, and Pampang) and improvement of urban canal system (pumping canal of Panampu and Jongaya). Makassar City should also prioritize balancing the coverage of green open space and mangrove forest particularly in the coastal and riverbank areas compared to the built-up areas.



ABSSUB-1130

SC 1.7 What is participatory planning for climate change adaptation? Do we need it? Do we have time for it?

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Research question: Organised communities can become resourceful actors for climate change adaptation when given the opportunity to take part in structured process of decision-making. Cross-sector partnerships refer to a variety of institutional mechanism whereby actors with different interests can work together to achieve a common objective. Organised communities, thus, can play a key role in cross-sector partnerships, both as full members or as critical friends. Yet, what is community is in itself under question- both in terms of whether communities actually exist but also, in terms of the extent that they can be recognized as meaningful partners by the government or the private sector. How can we deliver effective, community-based participatory planning for climate change adaptation?

Methodology: This paper will present a critical analysis of a participatory planning exercise in which we worked with communities in Maputo, Mozambique, to develop climate change adaptation plans for their neighbourhood. Participatory planning focused on the formation of a Climate Planning Committee (CPC) which then helped to build up relationships with other city-wide partners for the advancement of climate change adaptation objectives. Following the participatory planning exercise, the CPC has implemented some community proposals, such as the establishment of a community-based brigade to clean neighbourhood drains. The participatory process has also reinforced the structure of an existing Community-Based Organization for development and increased the participation of local residents in formal city politics. The experience of participatory planning is reported in a forthcoming book, which makes an argument for recognizing the importance of contextual knowledge to identify specific risks, how they affect residents and who can respond most effectively.

Findings: Following this experience this paper argues for participatory planning for climate change as a means for institutional development, which focuses on a people-oriented approach to urban governance. The experience also shows that participatory processes can improve the efficacy of planning in addressing the needs of people living in informal settlements, hence also addressing concerns about the time intensive nature of participatory processes.

Significance for practical solutions: We argue for municipal governments to embrace participatory methodologies as a means to build cross-sector partnerships and extend their capacity to deliver sustainable futures.



ABSSUB-1291

SC 1.7 Challenges of adaptation to the increasing flood risk in cities: lessons from the Pearl River Delta

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Research question: In some of the delta cities which are the most exposed to flooding caused by climate change - like Shenzhen and Guangzhou investigated in this paper - there is surprisingly little recognition of this problem and hardly any action is taken to address it. This paper draws on the insights from these two cases to address the following research questions:

1. Why certain delta cities ignore climate change risks?
2. What are the obstacles to the emergence of spatial strategies considering climate change adaptation?
3. How do the characteristics of the national governance systems within which cities operate constrain or facilitate their ability to devise integrated responses to climate change impacts?

Methodology: The study draws on qualitative research methods. In addition to desk research and analysis of secondary data, the study draws primarily on semi-structured interviews with the representatives of the relevant municipal and provincial officials and range of spatial planning and water management experts from academia and the private sector.

Findings: The paper focuses on the role of interests, ideas and institutions in determining the capacity of cities to respond to the growing flood risk in the context of climate change. Such a response requires cooperation across levels of government, administrative boundaries and policy sectors (spatial planning and land use, water management, economic development policy). The study stressed, however, that in the cities under investigation these sectors function in silos with only formalistic coordination, which reflects the wider characteristics of the Chinese policy-making. Moreover, the research highlights the tensions between the priorities in urban development, land use and water management, which render the cities more vulnerable to flooding induced by climate change and help explain why climate change risks are largely ignored in planning and design of the new extensions of the cities. Finally, the findings indicate that while the Chinese national government recognises the risks associated with climate change and pushes the sub-national authorities to develop climate adaptation strategies, the city governments largely resist this pressure and continue to prioritise urban development at breakneck speed, ignoring climate change risks. These tensions and conflicts of interests are a fundamental obstacle to the emergence of urban climate adaptation strategies in the Pearl River Delta's cities.

Significance for practical solutions: The study underscores importance of horizontal and vertical coordination of policies for the city's willingness and ability to devise adaptation strategies. It enhances our understanding of institutional factors, ideas and conflicting interests and policy priorities that critically affect the capacity of cities to adapt to climate change.



ABSSUB-1540

SC 1.7 Benchmarking flood risk management practices in Asian coastal megacities: Hong Kong and Ningbo cases

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Research question: Which barriers and constraints that are currently the major challenges for the coastal megacities to achieve a better, long term and more sustainable flood risk management practices, what can be done to overcome these barriers, and what can do better in the light of climate change and continuous rapid urbanisation.

Methodology: In this presentation the results of my findings from the case studies on the coastal megacities – Ningbo and Hong Kong from benchmarking the current flood risk management (FRM) practices by a developed conceptual sustainable flood risk assessment (SFRA) framework. The data for benchmarking is from primary (semi-structured interviews) and secondary data (grey literature). The aim of the discussion is to demonstrate the findings to practitioners and sharing the current constraints and barriers that against the coastal megacities to deliver a long term sustainable flood risk management practices.

Findings: Currently, coastal mega-cities in East Asia have emerged rapidly over recent decades, transformed from a primarily agricultural to a manufacturing and processing economy. Inversely, some cities are recently under severe stresses from urbanisation, massive population growth and often without strategic planning of coastal land use areas. This has led to extensive coastal land reclamation and installation of essential developments in coastal flood-prone areas. Disastrous coastal floods were occurred from typhoon enhanced storm surges in Ningbo during October 2013, and Hong Kong during September of 2008 and 2009, caused severe socio-economic damages to both cities. With respect of future climatic uncertainties, projected global sea-level rise and increasing recurrent storms and uprising urbanisation rate are accordingly posing some foreseeable threats for these coastal mega-cities in East Asia. Present patterns of coastal development are over-focused on socio-economic perspective, mostly overlooked flood risk and climate change adaptations, and simply not sustainable.

Significance for practical solutions: In this research, a sustainable flood risk appraisal framework appraisal (SFRA) framework has developed from global best practices and literatures. This paper uses two East Asian coastal megacities, namely Ningbo and Hong Kong for the study cases, and seeks to benchmark against this SFRA framework for understanding the current constraints and differences in prevailing perceptions of flood risk management practices. Through the study of these two cases, climate change adaptation policies, particularly on addressing future coastal flood risk is surprisingly lacking in these cities. It calls for some opportunities to re-think current coastal management and climate change adaptations strategies, with better public participation, education, raising awareness, flood risk recognitions and integrated with shoreline land use planning are necessarily being the first steps to progress.



ABSSUB-772

SC 1.7 Options for tackling obstacles experienced by construction companies who want to work on adaptation

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Research question: Which obstacles are encountered by construction companies who want to work on climate adaptation and are willing to innovate, and what can be done by which parties to overcome these obstacles

Methodology: In this presentation the results of an inventory, performed by Deltares, of obstacles for construction companies and suggestions for solutions, are presented. The inventory was based on a wide range of recent studies and focusses on the situation in The Netherlands. But on prominent aspects, the Dutch situation is typical for that in other countries. The aim of the discussion in this session is to explain the findings to practitioners, stimulate actions to solve the identified obstacles, and combining the findings in The Netherlands with insights from scientists and practitioners from other countries.

Findings: Adaptation is not yet part of, or a criterion in public tenders and contracts. And when adaptation is not ranked high on the political agenda, and there are no legal regulations or norms for adaptation, companies that offer adaptive solutions will not be able to make this a competitive advantage. Simply put: there is no (substantial) market for adaptation. The good news is however, that stakeholders (including governments) recognize these obstacles and are willing to make or stimulate necessary changes. And these changes are vital for adaptation. Without a healthy market for adaptation measures in which innovation is rewarded with commissions for construction, adaptation will not proceed fast enough or even come to a standstill.

Significance for practical solutions: The climate adaptation in cities 'scene' consists mostly of scientists, advisors, concerned citizens and policy specialists of municipalities and the national government. The (private) companies that have to realize and actually build climate adaptation measures, are not yet, or only marginally, represented in the adaptation community. Also, in adaptation pilots and research projects, in The Netherlands, building companies are often not fully involved. This has partly to do with the current phase of the adaptation process: the focus in the past years was (justly) on the indispensable research of climate scenarios, effects, risks, strategies and ideas on types of measures. Because of the latter e.g., urban planning & design companies are well connected to the adaptation community, but construction companies are still under-represented in the mix. But that situation is changing. More and more companies are inventing measures and technology, like actual adaptive building blocks, and offering these in the market place. But here is where they experience prominent obstacles.



THEMES

1. CITIES AND INFRASTRUCTURE

SC 1.7 DEVISING SOLUTIONS TO ADAPTATION CHALLENGES IN CITIES

ABSSUB-843

SC 1.7 The Portal Heat Island effect

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Research question: The focus of climate change adaptation in port areas has a clear focus on the impact of sea level rise. When looking at recent urban heat island studies, it can be concluded, that ports are hotspots within in cities, which raises the question, whether adaptations to the urban heat island effect should also be considered. In the recent 'Hotterdam' project, the implications of the Urban Heat Island effect on the quality of life in the City of Rotterdam were analysed. Since the port is not a residential area, a large part of it was not taken into account. However, from an economic point of view, negative impacts of heat in the port area can have serious consequences, as a large section of Rotterdam's working population is employed in the port area, and many businesses are highly dependent upon port activities.

This paper presents the ideas for a research on heat effects on the dry infrastructure (such as roads, railways, traffic signs, light posts etc.) in the port area and suggests guidelines to pre-empt the negative effects. "How does the Urban Heat Island effect influence the asset management of the dry infrastructures of the Port of Rotterdam?"

Methodology: Thermal satellite images will be analysed and combined with on-site temperature sensors to develop a heat map. The infrastructure objects will be identified and located on a GIS map, the so-called object map. The heat map will serve as an overlay over the object map for a risk assessment that identifies and classifies risks for the assets in the port area.

Findings: Based on the risk assessment, guidelines will be developed for adaptive maintenance strategies that over time will make the port infrastructure assets more climate proof, firstly in the Port of Rotterdam, but to be extended to port areas worldwide.

Significance for practical solutions: Therewith this research will contribute to the climate resilience of these drivers of economic development.

ABSSUB-217

SC 1.7 Hotterdam: the health and land-use implications of the Rotterdam urban heat island

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Research question: Which areas of Rotterdam experience the urban heat island effect most strongly, and what is the relationship between the outdoor temperature and homes heating up? Is there a link between the heat problems in the city of Rotterdam and public health, in relation to the increased levels of mortality among those aged 75 and over? Can the differences in heat between the districts of Rotterdam be explained on the basis of physical features of the city?

Methodology: The Hotterdam research project encompassed three key points: urban heat, social factors and physical factors. Main methods used were: measuring, mapping and analysing.



Urban heat and the surface energy balance were determined using crowd sensing and remote sensing. Social and physical factors were identified with the help of satellite images, GIS and 3D models. The links between urban heat/surface energy balance and social/physical factors were determined with the aid of multivariable regression analysis. The social and physical features that matter were then clustered and incorporated in the social and physical heat maps. The resulting heat maps and underlying data offer an understanding of the mechanisms that make the residents of Rotterdam vulnerable to heat waves.

Findings: In different ways, the pre-war districts of the city (North, South, and West) are warmer and more vulnerable to urban heat than are other areas of Rotterdam.

The temperature readings that were carried out confirm these findings as far as outdoor temperatures are concerned. Indoor temperatures vary widely. Homes seem to have their own dynamics, in which the house's age plays a role. The above-average mortality of those aged 75 and over during the July 2006 heat wave in Rotterdam can be explained on the basis of a) the concentration of people in this age group, b) the age of the homes they live in, and c) the sum of sensible heat and ground heat flux.

A varying mix of impervious surfaces, surface water, foliage, building envelopes and shade make one area or district warmer than another.

Significance for practical solutions: The research project produced two heat maps (social and physical), an atlas of underlying data and a set of adaptation measures which, when combined, will make the city of Rotterdam and its inhabitants more aware and less vulnerable to heat wave related health effects. The idea behind the heat maps is to find out where in the city land-use and the vulnerability to hot weather leads to problems for the elderly in particular. Any local authority seeking to manage its policies in a targeted way, rather than for the entire city, would be best advised to start taking measures, and informing residents and home owners in priority areas.

The idea behind the physical heat map was to find out where in the city the features that strengthen the urban heat island occur. This information shows which combinations of spatial usage are better avoided and which should actually be applied more frequently, with a view to making the city cooler.

ABSSUB-922

SC 1.7 Economic evaluation of potential adaptation strategies against sea level rise in Los Angeles County

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Research question: The National Research Council (NRC) estimated for Los Angeles County (LAC) a likely sea level rise of 0.5m in 2050 and 1.4m in 2100, which raised many questions on the coastal vulnerability of LAC. The aim of this paper is to assess potential flood damage and risk in LAC for various sea level rise scenarios and evaluate potential adaptation strategies for the LAC in terms of their costs and benefits.

Methodology: A damage-scanner model is used to assess the total economic damage per scenario. Subsequently, probability loss curves are made to calculate the (reduced) expected annual damage. Then lastly, the reduced expected annual damage and a cost estimation for each adaptation strategy are used for a cost benefit analysis.

Findings: The expected annual damage for the LAC is estimated at \$100.9 million per year without sea level



THEMES

1. CITIES AND INFRASTRUCTURE

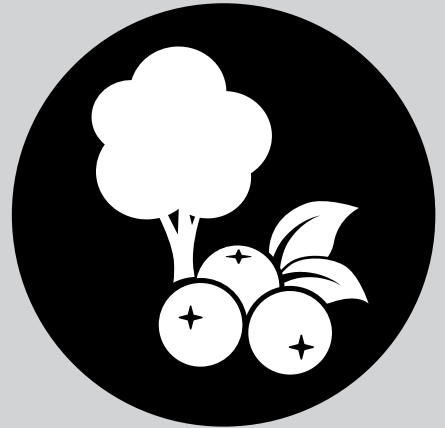
SC 1.7 DEVISING SOLUTIONS TO ADAPTATION CHALLENGES IN CITIES

rise, and at \$155.1 and \$313.3 million per year for the 2050 and 2100 sea level rise scenarios, respectively. Three adaptation strategies, varying from large scale engineering adaptations to small scale resilience measures (e.g. flood proofing houses), are proposed with initial investment costs ranging between \$0.6 up to \$9.4 billion.

Significance for practical solutions: It is shown that the resilience strategy, consisting of mainly beach nourishment and dry flood proofing of vulnerable buildings, is most economically attractive, and thus decision makers could use these findings to support adaptive planning. However, combinations of the different adaptation strategies on a smaller scale, instead of taking LAC as a whole, may result in more optimal and economically attractive adaptations.

THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS





THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.1 NEW METHODS IN MODELLING CLIMATE CHANGE IMPACTS AND ADAPTATION

ABSSUB-827

SC 2.1 Livestock system transitions as an adaptation strategy for agriculture

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Research question: Over the coming decades, climate change will affect the natural resource base of livestock production. A recent study by I. Weindl, H. Lotze-Campen, A. Popp, C. Müller, P. Havlík, M. Herrero, C. Schmitz and S. Rolinski assesses implications of different climate projections for agricultural production costs and land use change and explores the effectiveness of livestock production system (LPS) transitions as an adaptation strategy. By contrasting effects of different LPS transition pathways, the study provides insights into how related changes in feed conversion efficiencies and feed composition buffer or amplify secondary climate impacts in the light of the changing availability of natural resources.

Methodology: The impacts of climate change and shifts in LPS on agricultural land use and production costs are explored with the Model of Agricultural Production and its Impact on the Environment (MAgPIE) that represents key human-environment interactions in the agricultural sector by combining socio-economic regional information with spatially explicit data on biophysical constraints provided by the Lund-Potsdam-Jena dynamic global vegetation model with managed Land (LPJmL). LPJmL simulates growth, production and phenology of 9 plant functional types and of 12 crop functional types as well as managed grass, ensuring global balances of carbon and water fluxes. Acknowledging the uncertainty involved in simulating future climate conditions and related impacts, the sensitivity of the results to the choice of general circulation and crop growth model is tested.

Findings: Climate impacts on crop yields and rangeland productivity are estimated to generate adaptation costs amounting to 3% of total agricultural production costs in 2045 (i.e. 145 billion US\$). Shifts in livestock production towards mixed crop-livestock systems represent a resource- and cost-efficient adaptation option, reducing agricultural adaptation costs to 0.3% of total production costs and simultaneously abating deforestation by about 76 million ha globally. The relatively positive climate impacts on grass yields compared with crop yields favor grazing systems inter alia in South Asia and North America. General responses of production costs to system transitions are robust across different climate and crop models as well as regarding assumptions on CO₂ fertilization, but simulated values show a large variation.

Significance for practical solutions: Public policy support for agricultural research and development has to target a potentially wide range of future climate outcomes. In the face of these uncertainties, changes in the way livestock are reared represent an effective lever to improve agricultural resource management and economic outcome as well as a low risk adaptation measure with various co-benefits, possibly even contributing to emission reduction. Agricultural and climate policies should be reconciled to allow livestock production to respond to both mitigation and adaptation imperatives.



ABSSUB-467

SC 2.1 Integrated assessment of high-end climate change on land and water sectors

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Research question: 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 their potential impacts. Furthermore, high-end scenarios may lead to amplified interdependencies between different land use sectors (e.g. agriculture, forestry, water) highlighting the importance of employing a systematic approach for modelling impacts and vulnerabilities. Understanding cross-sectoral impacts is important in developing appropriate integrated land and water adaptation strategies to high-end climate change, since such insight builds the capacity of decision-makers to understand the full extent of climate change vulnerability, rather than viewing single sectors in isolation. The IPCC AR5 (Kovats et al. 2014) states *“Little information is available on integrated and cross-sectoral climate change impacts in Europe, as the impact studies typically describe a single sector [...]. This is a major barrier in developing successful evidence-based adaptation strategies that are cost-effective.”* In this presentation we explore the research question: do impact assessments that do not account for cross-sectoral interactions have the potential to misrepresent impacts and, thus, the need or otherwise for adaptive action?

Methodology: A regional integrated assessment model that captures interactions between six sectors (agriculture, forests, biodiversity, water, coasts and urban) was used to investigate impacts resulting from intermediate and high-end climate change scenarios. Results were analysed to assess the relative importance of climate vs. socio-economic scenarios and the effect of uncertainty in intermediate and high-end projections of climate change for each sector and the complex interactions between them. Furthermore, we compared 14 impact indicators (including food provision, irrigation use, intensive/extensive agricultural land use and managed/unmanaged forestry), derived from a common set of impact models run within single sector and integrated frameworks.

Findings: We show that single sector studies misrepresent the spatial pattern, direction and magnitude of most impacts because they omit the complex interdependencies within human and environmental systems. Furthermore, the discrepancies between the single sector and integrated model outcomes are more pronounced under different socio-economic scenarios than different climate scenarios, and at the sub-regional rather than Europe-wide scale.

Significance for practical solutions: Ignoring cross-sectoral effects of both intermediate and high-end climate change can lead to either over- or under-representation of impacts, and consequently to poor decisions about adaptation. As a consequence, caution should be given to using the outputs from stand-alone sectoral models to inform adaptation policy.



THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.1 NEW METHODS IN MODELLING CLIMATE CHANGE IMPACTS AND ADAPTATION

ABSSUB-451

SC 2.1 Modelling adaptation strategies for swedish forestry under climate and global change

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Research question: Our planet's land surface is today under intense pressure. Changing patterns of consumption and the demands of a growing human population drive competition for a limited land resource between food producers, resource extractors, nature conservationists or urban developers amongst others. In Sweden, forests are among the country's most valuable natural resources. The Swedish forestry sector is expected to be significantly affected by climate change, while demand for woody biomass is anticipated to vastly exceed the potential supply in Europe by 2030, putting a very high pressure on Swedish forest resources and likely forcing difficult trade-offs between forestry policy goals. Under such uncertain prospects there is an obvious need for further in-depth studies of potential future forestry-related land use transitions in Sweden, to better understand possible changes in future forest management and ecosystem service provision.

Methodology: Given the importance of incorporating human behaviour and decision-making processes to the study of complex socio-ecological systems, an agent-based model (CRAFTY-Sweden) has been developed that allows exploring Swedish land-use dynamics and adaptation to climate change through scenario analysis.

Findings: In CRAFTY-Sweden land managers make land use and management decisions according to their objectives and capabilities. As a result of their management and location characteristics (i.e. capitals) they are able to produce ecosystem services. Institutions may also influence the system through their actions. Both managers and institutions can manifest adaptation mechanisms.

Significance for practical solutions: CRAFTY-Sweden showcases the benefits of agent-based models towards a greater understanding of the adaptation process. Results and information deriving from our modelling exploration will be used in forestry stakeholder engagement exercises, and more generally to inform them about potentially most successful strategies to adapt to climate change.



ABSSUB-521

SC 2.1 Lidar and rice agriculture: flood modelling and farmer participation for adaptation

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- 2 Phil-Lidar 1 Hazard Mapping of the Philippines using LiDAR, Quezon City, Philippines

Research question: How can farmer's participation and flood modelling be integrated for adaptation to flood in rice agriculture?

Methodology: The study made use of a flood modelling approach with farmer's participation using Light Detection and Ranging (LiDAR), Geographic Information Systems (GIS) analysis, and focus group discussions (FGD) to create rice cultivation zone maps. The study was conducted in Apalit, Pampanga a municipality in the Philippines that has been experiencing the negative effects where some of its farmers reducing cropping cycles or changing their cropland to other uses.

A FGD with Apalit's farmers was conducted to gain information on current flooding conditions, flood experiences, currently used rice varieties, as well as validate currently available flood maps. The information gathered from the FGD was used to aid in the selection of the flood modelling approach and in the suggestion of practices and varieties. A flood modelling approach focused on surface flooding was selected. LISFLOOD-FP was used to generate the flood models using rainfall, riverine discharge, friction values, and a LIDAR digital elevation model (DEM) with a grid resolution of 5m as main inputs. Models of flood depth and duration were generated. The flood depth models were further processed to derive the mean depth of floods over the duration of the simulation. The mean depth and duration models were then processed in a Python program to create the rice cultivation zone maps. The classification of the rice cultivation zone maps were derived from the depth and duration thresholds at which rice plants can survive. The rice cultivation zone maps were then validated during a follow-up presentation to the municipality's farmer leaders and municipal agricultural office.

Findings: Rice cultivation zone maps for 5, 25, and 100 year rain return scenarios were generated. There are four zones depicted in these maps. Of particular note are Zones 1 and 3. Zone 1 is where both the depth and duration of floods exceed the threshold at which rice plants can survive while Zone 3 is where regular varieties can be planted without experiencing any negative effects. It was found that as the rain return scenarios progressed the area of Zone 3 decreased while the area of Zone 1 increased. From the FGD the study was able to gather that certain non-submergence tolerant varieties used by some farmers in the municipality were able to thrive in spite of extreme floods and are suggested for areas found in Zone 1. It was also found that the zone maps generated from the study were more accurate than the currently available flood maps.

Significance for practical solutions: The rice cultivation zone classification as well as the approach used to generate these will prove to be helpful for rice cultivation areas suffering from flooding. The zone maps easily identify areas which are in need of aid while the farmers' participation can aid in the identification of local adaptation practices as well as provide a participatory approach in the validation of the maps.



THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.1 NEW METHODS IN MODELLING CLIMATE CHANGE IMPACTS AND ADAPTATION

ABSSUB-849

SC 2.1 Climate change effects on agriculture. Trends in 2100-production for the Mexican region of Tabasco

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Research question: The lagoon of Carmen-Pajonal-Machona, located in the state of Tabasco (Mexico) stands out for its biodiversity and environmental richness. Around the lagoon, most families reside in rural areas and are engaged in primary sector activities to sustain their income level, such as agriculture and livestock. However, agriculture productivity is been recently affected by pollution of water bodies (derive from oil extraction activity) which affects soil conditions and its fertility. In such a context, a very important role in determining future amounts of agriculture production is played by climate change effects. Future trends in precipitation and temperature levels as well as the frequency and intensity of future extreme weather events will be responsible for the final food production scenario.

We present an estimate of the impacts of climate change (temperature, precipitation, salinity) on agriculture production for specific areas located around the Carmen-Pajonal-Machona lagoon, in the Mexican region of Tabasco.

Methodology: We rely on the two climate scenarios RCP8.5 and RCP4.5 for the years of 2030 and 2100, associated respectively with a CO₂ concentration leading to an average world temperature of, respectively, 2°C and 4°C in 2100. Future trends in temperature and precipitation are derived by using state-of-the-art coupled global climate models (GCMs) produced for the fifth Coupled Model Intercomparison Project (CMIP5), applied over southern Mexico.

Climate change effects are derived for several crop types, which have been chosen according to their level of relevance for the local economy. Changes in production are estimated distinguishing between the effects exerted by a single stress factor (temperature, precipitation, salinity) and those produced as a joint response.

Findings: The results show that coconut and cocoa are still in a "not so critical" temperature and rainfall range, with respect to other crops considered. If salinity increased, cocoa would suffer more than coconut, due to its low resistance to seawater salinity. Banana and corn, although for different reasons, show significant decreases in production performance due to temperature rise and low and extreme precipitation. Overall coffee results to be the most impacted crop.

Significance for practical solutions: This article identifies vulnerabilities to climate change in a market sector directly linked to food security.

It enables to shed lights on the need for adaptation for local communities whose income and nutrition levels are directly affected by climate change effects.

The identification of specific adaptation measures and policy orientation can be derived from our results.



ABSSUB-488

SC 2.2 Diversification as adaptation: insights from livelihood and crop diversification in semi-arid India

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Research question: The last two decades in India has seen a substantial decline in the contribution of agriculture to the total economic output with a slow but steady shift away from farming into non-farm activities. Diversification of livelihoods and crops grown is commonly considered an effective adaptation option, especially in the case of developing countries where credit markets are imperfect and rural infrastructure is inadequate. Existing research has also shown that movement toward non-farm employment and greater production diversity has reduced poverty in India. While these studies have encouraging policy relevance, they take a static viewpoint of an inherently dynamic situation that is marked by temporal changes such as seasonality and market dynamics. In this paper, we ask three key questions: What is nature of livelihood and crop diversification strategies being adopted by the farmers in India? Are these decisions driven by the “push” factors- rural distress and uncertainty from increasing climate variability, or “pull” factors such as urban proximity or more remunerative livelihood avenues? Can the occupations, jobs, crop and livestock mix used by households be termed as adaptive in nature? While answering these questions, we focus on small landholders who are differentially vulnerable to climatic and non-climatic risks and worst affected by idiosyncratic shocks.

Methodology: We use the nationally representative large-scale farmer household surveys carried out by the Government of India. These surveys contain an exhaustive list of information on the socio-economic profile of farmers and their current farming practices. A comparison over the period ten-year period 2003-04 and 2013-14 provides a nuanced understanding of changes in livelihood diversification patterns in rural India.

Findings: Diversification of livelihoods and crops farmers grow is often invoked as adaptive strategies that help farmers cope with and prepare for uncertainty and risks. However, non-farm occupations in the informal sector are often marred by exploitation and poor labour regulatory framework and may not lead to reduction in farmer vulnerability. Similarly, producing a crop-mix which is profitable but water intensive is unsustainable and potentially maladaptive in the long term.

Significance for practical solutions: Our findings are relevant to the contemporary policy and research discourse on building resilience of farming systems and enhancing adaptive capacity of farmers reeling under rural distress on account of climatic variability, natural resource degradation, market fluctuations, and input-intensive farming. By critically analysing the implications of diversification on farmer adaptive capacity, we suggest that while diversification is a useful risk management strategy, adaptation projects in rural India need to interrogate *diversification into what and diversification by whom?*



ABSSUB-492

SC 2.2 Impact of climate change on farmers' livelihood in a developing country: India

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Research question: The present study was taken up to analyse the impact of climate change on farmers' livelihood in Bengaluru district, India, where the water has been depleting over the years due to deficit rainfall.

Methodology: The villages were selected purposively from a project area 'Economic Impact of AAS (Agromet Advisory Services) of NCMRWF (National Centre for Medium Range Weather Forecasting) which was taken up by AICRP on Agro meteorology. Biprobit model has been applied to identify factors that influence the farmers' perception about changes in precipitation and temperature during the past fifteen years. Binary logit regression model was applied to know farmers' adaptation strategies to climate change effects. Garrett's ranking was applied to assess the constraints expressed by the farmers against climate change.

Findings: The results revealed that farmers with more farming experience, education and access to climate information are more likely to perceive changes in rainfall and temperature. There is fall in the crop yields because of changes in the climatic parameters and the loss in income due to crop failures may be made good through diversification of enterprises. This clearly shows that, farmers were well aware of climate change problems and the extent of ill effect on agriculture. The diversification of crops both in AAS and control farmers area may be due to the shortage of irrigation water during crop growth and increased temperature. The per acre cost of cultivation for most of the crops in control farmers was more than that of AAS farmers. This increased cost may be due to increased labour costs, increased quantity of seeds used, increased FYM and fertilizer costs because of unavailability of AAS. The analysis revealed that the yield levels of ragi, red gram, field bean, tomato and grapes were observed to be more for the AAS over control farmers. The results revealed that age, education, farm size, membership in cooperatives and family income were significant. Farmers in the study area have given rank I to difficulty to work in the field due to severe temperature. Farmers expressed that there was scarcity of labours and were given rank II.

Significance for practical solutions: The results indicated that providing early warning signals to the farmers about the climate change, creating awareness among farmers about appropriate adaptation measures against climate change and provision of subsidies were the three most important suggestions given by respondent farmers. Providing financial support for soil nutrient enrichment and incentives or support for increasing the application of green manure were given least ranks. Need to improve early warning systems about climatic parameters in order to avoid the ill effects. As migration is a serious issue, policy makers have to initiate suitable programmes to reverse the trend. AAS need to be developed all over the country to mitigate the effects of climate change.





ABSSUB-794

SC 2.3 Fitting neglected and underutilised crops into climate change adaptation strategies

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Research question: Agriculture is the predominant activity sustaining livelihoods of about 70% of people in sub-Saharan Africa. About 95% of agriculture is primarily rainfed. Climate change and variability are predicted to result in increased variability of rainfall, severity and intensity of extreme weather events such as drought and floods. It is expected that water will be the primary medium through which climate change impacts will be experienced. This threatens agriculture and food security in an already food insecure environment. Consequently, there is need to develop solutions to assist farmers to adapt to climate change. Whilst mainstream efforts are focussing on major crops, the potential of underutilised crops has not been fully exploited.

Methodology: The objective of these trials was to evaluate resilience of selected underutilised crops under a range of environments. Conventional and modelling approaches were considered. Over a series of experiments conducted from 2008 to 2013, a range of underutilised crops were evaluated in field trials using randomised complete block designs. to determine aspects of their agronomy, water use, drought and heat tolerance. Crops evaluated included maize landraces, wild mustard, taro and Bambara groundnut. Intercropping was also considered for taro and Bambara groundnut. In addition, the FAO's AquaCrop Model was also calibrated and validated for taro and Bambara groundnut.

Findings: Underutilised crops are mostly drought tolerant and adapted to low levels of water availability. The degree of drought tolerance varied among the crops studied. However, it was evident that the crops had characteristics that made them suited to unfavourable agro-ecological niches. Intercropping trials showed that it was feasible to intercrop underutilised crops and that this resulted in improved resource use under low input systems. Simulations of climate change showed that yield and water productivity of selected underutilised crops would increase in the response to climate change.

Significance for practical solutions: Underutilised crops are resilient and adapted to a range of agro-ecological niches, low input agriculture and have tolerance to abiotic stresses such as drought. This makes them an important future crops for sub-Saharan Africa's smallholder farmers on marginalised lands, especially under predicted climate change. Their inclusion in climate change adaptation strategies would offer sustainable solutions built upon existing agro-biodiversity within the region.



ABSSUB-1211

SC 2.3 Understanding food security in the context of drought: Evidence from subsistence farmers in Central America

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Research question: Smallholder agriculture in Central America are sensitive to climate change and very dependent on natural ecosystems. Despite climate change adaptation in the agricultural sector is vital to increase the resistance and resilience of productive systems, guaranteeing the livelihoods of millions of farming families, little is known about farmers' adaptation decisions, in-farm strategies, intensity and their relevance in terms of food availability in Central America. This research aims to assess farmers' climate perceptions, analyse how different factors determine the adaptive responses and explain what practices and strategies are better to guarantee wellbeing in subsistence systems in two countries: Honduras and Guatemala.

Methodology: In 2014 we conducted household surveys in four vulnerable farming landscapes in Guatemala and Honduras. Selected landscapes differ in climatic and socioeconomic indicators, including cash crops cultivation. We are using econometric techniques to identify the main determinants of the adaptation decisions identified in the survey, the relevance of reported changes, adaptation intensity and food insecurity in the four landscapes. We will explore different econometric approaches, including a binary decision (adapt versus no adapt), the specific adaptations chosen, the intensity of the adaptation effort and the famine distribution among farmers. The survey provides a wide range of alternatives, including farmer's characteristics, social capital indicators and access to training services among others.

Findings: Even though most of the farmers already perceive changes in climate (around 90%), the amount of them that have react by the implementation of changes in farm strategies or management is low and variable between study sites (24 to 51%). Reduction in agricultural production is a major issue that reduces family income and therefore food security, and seems to be deeper where the main extreme weather event suffered is drought, beyond more devastating events (hurricanes or floods). Adapted farmers report afforestation, alterations in the farming calendar or changes in management practices as strategies to struggle against drought. More analysis are necessary to explain adaptation drivers and assess the effect of adaptation practices and intensity in food security.

Significance for practical solutions: Understand how climate change will impact food availability and identify what responses will maintain or improve farmer's wellbeing will impact the adaptation opportunities for farmers, allowing them to build resilience and resistance to the impacts of climate change. Gathering findings related to driving factors and adaptive responses in subsistence farms, we could contribute to highlight farmer's needs and improve food security of subsistence communities in Central America. Provide policy advice and recommendations to promote adaptation in the agricultural sector and reach the embracement of appropriate and affordable practices by smallholders throughout the region is also relevant.



THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.3 FOOD PRODUCTION SYSTEMS



ABSSUB-1451

SC 2.3 Shrimp farming as adaptation to salt intrusion in coastal Bangladesh: A social tipping point

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Research question: Bangladesh a country situated in the Ganges-Brahmaputra-Meghna delta. Sea level rise in combination with reduced dry season flows and river engineering are projected to add to salt water intrusion. At present Bangladesh' agriculture is dominated by rice, accounting for more than 75% of the total cropping area of the country. Yet, in the coastal areas salt intrusion makes it increasingly difficult for farmers to grow rice and farmers look for ways to cope. Among the adaptation measures are canal re-excavation and using salt tolerant crop varieties. These adaptations remain in line with the tradition of rice cultivation. Another option is to switch to shrimp culture, which farmers turn to due to salt intrusion as well as high economic return. This shift is causing social tension and poses a threat to the rice ecosystem, as shrimp cultivation requires brackish water and farmers are found to actively let brackish water into cultivated areas. Once farmers start to switch it becomes increasingly difficult to continue to cultivate rice and other farmers are eventually forced to consider another livelihood. This paper studies the shift from rice to shrimp cultivation as a social tipping point. It asks at what thresholds rice farming becomes untenable and how different stakeholders interpret the sustainability of the shift to shrimp production.

Methodology: We take socio-economic and hydro-ecological data from Satkhira, one of the coastal districts of south-western Bangladesh and most vulnerable to salinity intrusion. Socio-economic data is obtained from interviews and county statistics. Hydro-ecological data is taken from field-observation and recent modelling studies of salinity in the coastal zone of Bangladesh under climate change. Adaptation pathways will be constructed in two focus group discussions among interviewees.

Findings: Salinity level in the Satkhira district rose sharply over the last few decades. Yield data and farmers interviews show how salinity had a substantial impact on rice cultivation and that shrimp farming is on the rise. We observe that shrimp farmers are richer and more powerful than rice farmers and do not frame the salinity issue as a problem. They indicate crop cultivation as an option to cope with even higher salt levels. There is conflict among stakeholders about the salinity issue and desired adaptation measures. Adaptation pathways show strong lock-in and hysteresis effect once the shift to shrimp farming has crossed a certain threshold. Part of the farmers indicate willingness to convert back to rice once salinity levels or crop characteristics allow this. Yet, this willingness is found to drop with time.

Significance for practical solutions: The research discussed for the case region how long adaptations measures and farming systems will be sustainable under climate change. As such it offers a case of a farming systems shifting to an alternative livelihood, whether this shift is equitable and what the possible adaptation pathways are.



ABSSUB-590

SC 2.3 Stretching boundaries for food production: identification and cultivation of salt tolerant potato

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Research question: Salinity is an increasing threat to food production, now and in the nearby future. The general approach is to reduce the soil salinization, usually by expensive means. In this case the authors have a different perspective, namely to identify a salt tolerant potato variety that can be cultivated directly on salt affected soils. The main research question is: what is the allowable salinity level for cost effective potato production under actual field conditions?

Methodology: Salt Farm Texel has set up a large research facility under field conditions in The Netherlands. At the research station fresh water and seawater can be mixed into any desired salt concentration. Seven different salt concentrations are used, each with 8 replications. In this way 56 plots of 160 m² are irrigated (total research location is 1 hectare) in which various crops are tested for salt tolerance. For the potato experiment, 8 tubers per plot were planted and these 8 plants were harvested jointly as one replicate sample. Root zone salinity is controlled by means of drip irrigation and frequent leaching. The actual root zone salinity (Electrical Conductivity, EC in dS/m) was measured in pore water samples and soil samples. During 4 subsequent years the fresh and dry weight of the tubers were determined.

Findings: Measurements of soil salinity showed that at the research facility of Salt Farm Texel the root zone salinity (EC) of the pore water was close to the EC level of the irrigation water. About 40 different potato varieties have been screened for salt tolerance and this has resulted in the identification of a potato variety that can withstand salinity levels about 3 times higher than previously believed to be possible. The maximum salt concentration at which no yield reduction was observed was at 5.7 dS/m (soil salinity, saturated paste method) and a 50% yield reduction was observed at 15 dS/m.

Significance for practical solutions: This salt tolerant potato has been introduced into the salt affected areas of Pakistan, with the help of the Securing Water for Food Program. In this program, which is supported by USAID and the governments of Sweden and The Netherlands, Salt Farm Texel collaborates with MetaMeta and Jaffer Agro Services. In the 2014-2015 season the growth performance of the salt tolerant potato under saline field conditions was validated in Pakistan at 4 different locations. Upscaling will take place in the upcoming season. The goals are to rapidly increase the potato cultivation on salt affected fields in Pakistan (salt affected area is around 6 million hectares) and start implementing the cultivation of the salt tolerant potato in many other salt affected areas in the world. Millions of hectares of salt affected arable land that are believed to be unproductive can be turned into commercial viable areas that can help feed the growing world population.



ABSSUB-1147

SC 2.4 Links between adaptation and climate change mitigation in forests

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Research question: A number of decisions under the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) recognise the potential for synergies between climate change mitigation and adaptation actions. In particular, actions for reducing emissions from deforestation and forest degradation (REDD+) and for adaptation can be complementary, although REDD+ actions will not be able to achieve all adaptation goals, and adaptation actions will not be able to achieve all REDD+ goals.

Methodology: Case studies and experiences from several partner countries of the UN-REDD Programme have been drawn upon to highlight the potential to enhance such synergies.

Findings: Ecosystem-based adaptation to climate change (EBA) may help to achieve REDD+ objectives. For example, conserving mangrove forests to counter storm surge flooding can also reduce greenhouse gas emissions. Additionally, by modifying future drivers of land-use change, some adaptation actions can also decrease the risk of reversals of emission reductions. Furthermore, actions that maintain or enhance the resilience of ecosystems can reduce the potential for emissions caused by the impacts of climate change on forests.

The implementation of REDD+ activities can maintain and enhance ecosystem services important for societal adaptation. REDD+ actions will also influence important aspects of adaptive capacity. For example, training on sustainable management of forests may build human capital for adapting forest use to climate change.

Significance for practical solutions: There are both shared challenges and potential trade-offs between REDD+ and adaptation. Some of these may be addressed through application of social and environmental safeguards; documenting and sharing experiences can help to support development of relevant safeguards and approaches for their implementation. Integrating both adaptation and mitigation into wider forest policy and the strategies and plans of related sectors, at local to national scales, can also help enhance synergies and minimise trade-offs.

ABSSUB-1302

SC 2.4 Development of a prioritization tool of climate change adaptation measures in the forestry sector

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Research question: How to prioritize the feasible measures to climate change adaptation in the forestry sector?

Methodology: Single methods have been used over the course of the research are: technical and scientific



THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.4 CLIMATE CHANGE ADAPTATION WITH MITIGATION CO-BENEFITS IN FORESTS AND WOODLANDS

literature review related to adaptation planning, alternatives and strategies, multi-criteria analysis, etc.; focal groups to test and improve the tool, and open and semi-structured interviews.

Central to the chosen methodology is the Analytic Hierarchy Process (AHP) using the Pair wise comparison, based on Saaty (1990, 2008). This method has proven to be useful for different sectors and objectives (Vaidya & Kumar, 2006).

Findings: In order to fill the gap related to tools which help to prioritize adaptation measures, the "prioritization tool for climate change adaptation measures in the forestry sector in Nicaragua" was developed.

The tool is organised around three main steps: (i) the identification of potential adaptation measures, (ii) a catalog of criteria and indicators for the evaluation of those measures and (iii) a multi-criteria analysis for the prioritization of the identified and evaluated measures. This is a multi-criteria tool based on the Analytical Hierarchy Process (Saaty, 1990, 2008), using various parameters as input to structure the decision-making process. Those are grouped in four different levels: criteria (social, economic, environmental and climate-related, etc.), sub-criteria, indicators and alternatives.

Through the development of a case study in Nicaragua, the proposed tool could demonstrate that using a multi-criteria tool and updated information can facilitate the decision-making process regarding adaptation planning and has the potential to reinforce the processes to enable bottom-up decisions. The tool and the results obtained were presented to Nicaraguan governmental officers, whom welcomed it. However, results also showed that refinements are needed in order for the tool be used in different contexts and sectors. At the moment, the tool is under improvement and validation process in order to be more easily transferable and thus used in a wider range of countries as well as at different levels of governance, where decision-making related to the adaptation to climate change takes place.

Significance for practical solutions: As developing countries frequently face limited financial resources for the implementation of adaptation measures, added to the absence of the National Adaptation Plans (NAPs), it is an imperative for them to have clear guidelines on how to select and prioritize the adaptation measures to be implemented. Therefore, the development of a prioritization tool, which considers the context of the region or sector of interest, the climatic scenarios and its expected impacts, the available financial resources and the available alternatives of adaptation measures, becomes a crucial step for the strengthening of the planning framework of developing countries in order to reduce their vulnerability to the impacts of climate change.

ABSSUB-905

SC 2.4 Linkages between forests and climate change vulnerability in the complex Himalayan landscape

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Research question: What are the consequences of changes in forest cover due to climate change on livelihood options of local communities?

Methodology: Ecological-niche based model was used to explore changes in forest cover in the Himalayan landscape. To study impacts of climate change, Maximum-Entropy Approach (MaxEnt) was used to simulate

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.4 CLIMATE CHANGE ADAPTATION WITH MITIGATION CO-BENEFITS IN FORESTS AND WOODLANDS



occurrence probabilities of the different forest types (geographically dominant oak and pine forests). In order to predict the possible potential forest types for future climate change scenarios, climate variables were considered depending on the availability of datasets. After the aforementioned analysis (identification of vulnerable regions), extensive field surveys were carried out to understand changes in livelihood options of local communities. Results of the social assessment helped in deciphering perspective of communities towards climate change. With both closed and open-ended questions, characteristics of village and nearby forests, and livelihood profiles were generated. With the aim to understand forest-people dependency and forest resource management, the need for assessments changes in reforms, government policies and interventions, and coping-adaptation mechanisms were understood and subsequently analysed.

Findings: Despite high vulnerability, impact of climate change on Himalayan forests has not been properly investigated, primarily due to inadequacy of data and complex topography. In this study, we mapped pine and oak forests in central Himalaya and projected it under RCP climate scenarios. Both observed as well as projected climate data showed statistically significant trends. The model predicted substantial area of under pine and oak forest would disappear by the end of the century which might severely impact local communities dependent of forests, both for subsistence and commercial purposes. The social assessment helped in understanding degree of dependency of local communities on forests and forest-based resources. The approach could be promising in predicting the potential distribution of dominant forest types and can be an effective tool in species restoration and forest conservation planning.

Significance for practical solutions: In our study, we can conclude that mixed models provide more accurate results for most of the combinations of climatic and non-climatic variables as compared to individual variable-based models. The analysis indicates that evaluation of climate variables alone may be insufficient to determine suitability of niche-models for studies of climate-forest interactions. By studying local dependency on forests and forest-based resources, we conclude with a framework that can guide future research to help understand, and hopefully adapt and mitigate, the negative effects of climate change on vegetation and the ecosystem services they provide.



THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.4 CLIMATE CHANGE ADAPTATION WITH MITIGATION CO-BENEFITS IN FORESTS AND WOODLANDS

ABSSUB-1001

SC 2.4 *Faidherbia albida* trees buffer impacts of climate change on wheat in semiarid farming systems

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Research question: Smallholder production systems in developing countries face severe threat from climate change. As a result of extreme heat during growing season, terminal moisture stress and photo-inhibition, accelerated by climate change, significant yield loss occur in many wheat growing regions of Africa. While urgent adaptation strategies are needed, conventional mitigation and adaptation strategies (such as new varieties, irrigation etc.) are neither affordable nor accessible for poor farmers in these regions. Locally available adaptation options that have been customized to local conditions and proven to fit to the existing systems need to be explored. The current work aims at exploring and quantifying the impact of *Faidherbia albida* – a common agroforestry species in many semiarid regions of the region – on adaptability and resilience to climate change of wheat farming systems.

Methodology: Mature scattered *F. albida* trees with uniform canopies were selected within farmers' fields to set an experiment. Locally adapted wheat cultivar was used. In-season and off-season air temperature, soil temperature, soil moisture, incident and transmitted radiations and soil variables were quantified under and close to the crowns of mature the trees under farmers' conditions. Wheat was grown under the crown and in the open for assessing the impacts. The experiment was set in six replications and repeated for three seasons.

Findings: Air temperature within the distance of seven meters from tree trunk was found to be lower under the canopy by 6°C, especially during heat sensitive periods of flowering and anthesis. Water use and water availability was significantly higher for wheat grown beneath the crowns as compared to wheat in the open during grain filling stage, which is susceptible to terminal stress under semiarid conditions. The trees also reduced the risk of photo-inhibition by lowering incident radiation from the maximum of 2200 $\mu\text{mm}^{-2}\text{s}^{-1}$ in the open to an average of 900 $\mu\text{mm}^{-2}\text{s}^{-1}$ under the crown of *F. albida* trees. As a result, higher overall biomass (26%), higher grain yield (24%) and more nutritious grains (more calories, and proteins etc.) of wheat was obtained from wheat grown in association with *F. albida* trees and the yield was found to decrease with distance from tree crowns.

Significance for practical solutions: These results demonstrate that *F. albida* contributes to adaptation to climate change of wheat systems by buffering it against extreme temperatures (which are predicted to become a more frequent event), supra-optimal radiation and terminal moisture stress. It also improves the nutrition security of the community. This calls for adaptation strategies that preserve – or even build upon – these locally available and easily adoptable options.



ABSSUB-1542

SC 2.5 Community based adaptation as a source of conflict: the Adaptation Learning Program (ALP) in Ghana

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Research question: What are the implications of Community-Based Adaptation (CBA) for natural resource use and conflicts in semi-arid landscapes?

Methodology: The paper is the result of an ethnographic study, focussed on conflict dynamics arising as a result of the implementation of the Adaptation Learning Program (ALP) by Care Ghana International (in association with local partners) in a semi-arid landscape in Ghana's Upper East Region (UER). During two fieldwork periods in 2014 and 2015, a daily extensive survey was conducted, as well a number of in-depth interviews with farmers, local opinion leaders, NGO project officers and local government officials. Secondly, as a compliment to the paper an innovative interactive map has been developed. The map serves both as an illustrative and a methodological tool.

Findings: The paper finds that adaptation interventions, including Community-Based Adaptation, implemented by development actors in rural communities, creates new winners and losers, and may generate new conflicts and/or intensify existing tensions as land and water resources come to be used differently, more intensively and/or redistributed in the context of competing claims to natural resources (communities, social groups, livelihoods etc.). As a result, increasing the adaptive capacity of one user group is likely to reduce the adaptive capacity of another. The paper proposes that practitioners take natural resources, rather than the community, as the point of departure for planned adaptation. In doing so, multiple-user groups (having competing claims) may be recognised and included in the design of adaptation interventions.

Significance for practical solutions: Conflict narratives receive relatively little attention in adaptation practice narratives, despite obvious links between adaptation, the common use of scarce natural resources and conflict. In problematizing popular community-focused approaches to planned adaptation, the paper calls for new approaches which take natural resources, rather than communities, as the point of departure for planned adaptation. By doing so planned adaptations may cater for multiple-user groups (of increasingly scarce natural resources), seeking practical adaptation solutions which combine a variety of local interests, and therefore mitigate increased risks of conflict between and within rural communities in semi-arid regions.



THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS

SC 2.5 GOVERNANCE, BARRIERS AND CONFLICT IN CLIMATE CHANGE ADAPTATION

ABSSUB-149

SC 2.5 Differentiated impact of barriers to adaptation: climate change adaptation in rural Ethiopia

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Research question: 1. How do male and female-headed households adapt to climate change
2. How do various types of - interconnected barriers- influence their respective adaptation choices?

Methodology: The study was carried out in two drought prone areas of Northern Ethiopia. Applying sustainable livelihood approach, data was collected using semi-structured interviews and focus group discussions with male- and female-headed households, community leaders and local extension workers. Forty three semi-structured interviews with household heads (20 with male household heads and 23 with female household heads) were conducted. Moreover, two mixed sex and one women-only focus group discussion conducted with community members. Narrative analysis was used to analyse transcribed interviews and field notes.

Findings: Our analysis shows the gender-based divergence in adaptation measures is neither a matter of preference nor of differences in perceptions between men and women on the extent and problematic nature of droughts, but an outcome of gendered barriers to adaptation. Gendered institutions create barriers to adaptation through rules, norms and practices and through generating more access barriers for women than for men. All in all, barriers to adaptation influence the adaptation process of households in a differentiated manner – i.e. due to gender norms and practices, female- and male-headed households encounter and experience barriers to adaptation in different ways. For instance, social barriers (e.g. the reciprocal labour exchange system) may very well facilitate the adaptation process of male-headed households (especially for poor households) whereas simultaneously hinder adaptation processes of female-headed households. Theoretically, we notice a growing interest in barriers to adaptation and strategies to overcome these. The findings of our study add new insights to the debate. The first notion is that despite the understanding of barriers as having an overall negative impact on adaptation (Biesbroek et al. 2013), we clearly show them to have a *differentiated* impact upon different actors. Recognizing this will enable the design of strategies to effectively overcome barriers to adaptation without compromising their facilitating role. The second notion relates with the connection among barriers to adaptation. As illustrated in our study, different barriers interact with each other and result in distinctive outcome for actors who are at the junction point of such interaction.

Significance for practical solutions: A practical implication of our findings is that (planned) interventions to overcome barriers to adaptation – by governments, donors and NGOs – should be inclusive of all actors. Failure to take cognisance of the interconnectedness among barriers to adaptation may lead to discriminatory outcomes where often disadvantaged groups such as female-headed households will end up with maladaptation.



ABSSUB-378

SC 2.5 Climate change perceptions and barriers to adaptation among drought prone farmers in india

Architesh Panda*¹¹ Climate Change Unit, International Rice Research Institute, Los Banos, Philippines

Research question: What are trends and pattern of rainfall in the study region in the last sixty years and Is the climate change perception of farmers similar with actual rainfall trend analysis? Can traditional knowledge be a reliable indicator of rainfall forecasting by farmers? What are the barriers to adaptation at household and community level in adapting to climate change? How farmers are transforming their agricultural practices at the local level?

Methodology: In depth Household survey and Focus Group Discussion for Field Data. Mann-Kendell and Sen' Slope test for rainfall trend analysis.

Findings: Results suggests that farmers perception are more likely to be similar with actual data analysis from the nearest rainfall stations suggesting towards the need to be more cautious while interpreting farmers perception at a larger geographical level and comparing it with actual rainfall data. Farmers perception are more likely to be similar with actual data analysis from the nearest rainfall stations suggesting towards the need to be more cautious while interpreting farmers perception at a larger geographical level and comparing it with actual rainfall data. Migration plays a major role in transforming people's perception on adaptation in agricultural practices. famers are undertaking transformational adaptation measures such as migration and shifting to new crops to deal with climate change. While lack of access to water and irrigation, information on climate change adaptation and early warning systems are major barriers to adaptation at the household level lack of government intervention was mentioned as the major barrier at the community level.

Significance for practical solutions: Local level planning for adaptation barriers. Understanding role of migration and information in adaptation practices. Promoting climate forecasting in underdeveloped regions.

ABSSUB-1379

SC 2.5 Climate smart agriculture: identifying barriers to adoption

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Research question: Agriculture is particularly vulnerable to the impacts of climate change, and is a vital economic sector, providing both food and energy. A changing climate will have differential effects on agriculture globally, as well as within regions. The continued and enhanced production of food is undoubtedly critical as the human population grows. Climate Smart Agriculture (CSA) has received considerable and growing attention in recent years, with the aim of 'sustainably increasing productivity, resilience (adaptation), reducing/removing greenhouse gases (GHGs) (mitigation) and enhancing achievement of national food security and development goals (FAO 2010). While CSA is not without its criticisms (e.g. IATP et al. 2015), and challenges certainly exist regarding the interactions between different actors, measurement tools and



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institutional responsibilities, the broad aims remain laudable. The ultimate effect of the physical impacts on agricultural systems will depend on the implementation of adaptation options. We know that many CSA practices provide benefits to the producer, in the form of increased productivity, reduced input costs, or enhanced resilience to climatic changes and extreme weather. Yet in many cases the practices are not being adopted.

This research aims to identify the barriers to adoption of CSA practices and technologies. In many ways this harnesses the growing literature on adoption of many types of agricultural technologies and also of innovation. We aim to identify what aspects beyond pure financial considerations are affecting uptake of CSA options, and what are the implications of these for policy makers.

Methodology: Through a systematic review of global literature and an analysis of policy environments in selected countries, we identify the key barriers to adoption of CSA practices and measures.

Findings: We find that barriers to adoption range from the policy environment and market conditions through to internal personal factors including cognition, attitudes, and habits, and social and cultural factors. A further important barrier are the often hidden transaction costs involved in changing practices or adopting new techniques.

Significance for practical solutions: The findings have important practical implications for policy makers aiming to maintain productivity against a changing climate. Identifying the relevant barriers to adoption of CSA practices in a particular country may enable appropriate policies to be designed to address these barriers or the adjustment of existing policies that may be creating perverse incentives or unintended barriers so that ultimately, agricultural production remains resilient in a changing climate.

ABSSUB-824

SC 2.6 The adaptation-development spectrum in dryland East Africa: mapping risks and responses

Roger Few*¹

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Research question: How can we characterise current responses to climate-related social-ecological risks in East Africa, and what implications does this have for climate change adaptation?

Methodology: The findings draw from a regional literature review for East Africa undertaken through the project Adaptation at Scale in Semi-Arid Regions (ASSAR) funded under the CARIAA initiative. The review drew on 260 publications covering a wide range of themes and sectors (e.g. agriculture, environment/resource management, disaster risk reduction, development, infrastructure, water, health, communication).

Findings: This presentation analyses some of the principal forms of response to social-ecological risks associated with climate variability and change in the drylands of Ethiopia, Kenya and Uganda. It reviews and categorises a broad terrain of response measures covering sectoral governance themes as well as measures focussed around support for livelihoods and wellbeing. This underlines that climate change adaptation cannot readily be viewed in isolation from wider societal and environmental concerns, and hence the presentation views responses within an 'adaptation-development spectrum'. Some are strategic in nature, designed to reduce underlying vulnerability of people and society in semi-arid areas; others are more akin to coping responses, through which actors attempt to deal with the immediate ramifications of shocks and stresses.



By analysing relative positions of responses on the spectrum it reflects on the equity and sustainability dimensions of approaches to risk management in general as well as actions specifically oriented to climate change adaptation.

Significance for practical solutions: Understanding how to strategically advance response options within the 'adaptation space' requires first an understanding of historic and contemporary responses: how have and how are people and society responding to the risks? Understanding this is important not just in terms of generating a baseline of current response modes, but also because progress in adaptation can conceivably come through the reinforcement of pre-existing adaptability. In essence, we need to understand actions in the present in order to explore the utility, equity and sustainability of actions for the future.

ABSSUB-362

SC 2.6 Developing drought resilience in irrigated agriculture in the face of increasing water scarcity

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Research question: After being affected by recurrent droughts, it is probable that UK irrigated farmers will have learnt from experience and implemented management changes to reduce their future drought risks. However, they do so in the face of increasing water scarcity due to legislative change and competing demands from other sectors. In this presentation, we explore the research question: Are irrigated farmers in the east of England becoming more resilient to droughts in the face of increasing water scarcity?

Methodology: This study combines quantitative agrometeorological data with qualitative evidence from farmers and regulator staff, to assess the severity of drought events since the 1970s and their impacts on irrigated agriculture:

- *Drought severity assessment:* assessed through the Standardized Precipitation Index and the maximum Potential Soil Moisture Deficit.
- *Online survey:* analysis of responses to a questionnaire on drought impacts; short and long-term drought management responses; and drought risk perception from 19 farmers in eastern England representing 32% of the total irrigated area in the region.
- *Semi-structured interviews:* template analysis of transcribed interviews with 10 farmers from the online survey.
- *Interviews with water regulatory staff:* drought coordinators in the region describe their roles, and the regulatory actions and responses (including imposing water abstraction restrictions on irrigation) in recent droughts.

Findings: Results show that the impacts of past droughts on irrigated agriculture in this region have decreased over time, despite little change in abstraction restrictions or bans. This arises from irrigated agriculture becoming more efficient; more coordinated through Water Abstractor Groups that facilitate improved dialogue with the regulator; and more resilient to droughts due to investment in alternative water sources, mainly on-farm reservoirs. However, the regulator has also evolved its drought management relationship with agriculture in this region, becoming less top-down and more engaged and proactive.

Significance for practical solutions: The results highlight the importance of a vertically integrated drought



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management approach for reducing the impacts on agriculture. However, future increasing droughts frequency and water scarcity requires more collaborative management of catchment water resources, where agriculture can have a more important role; improved seasonal forecasting to allow farmers to plan for future water related risks; improved (re-)allocation of water resources within agriculture and a more equal sharing of the burden of drought impacts across multiple sectors informed by an improved evidence base of the impacts of abstraction on ecology and resilience in ecological drought recovery.

ABSSUB-302

SC 2.6 Application of a triangular fuzzy AHP approach for flood risk evaluation – a case study

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Research question: A flood is a natural event that can have far reaching effects on people and environment and it is most common type of disaster in almost all countries in world, This paper aims to find an effective method to establish a flood risk evaluation and prediction system for flood-prone locations in Andhra Pradesh an agro based state in India housing two major rivers called Godavari and Krishna. Flood risk evaluation is an intrinsically complex multidimensional process (Li et al. 2012). According to characteristics of flood risk analysis, our paper used triangular fuzzy AHP model for ranking of vital risk indexes, comprehensive flood risk prediction in state.

Methodology: A hybrid evaluation model is constructed based on fuzzy AHP and triangular fuzzy number (TFN). AHP is an excellent performer in dealing with interdependent criteria and local problems involving both quantitative and qualitative. And fuzzy set theory deals with sets or categories whose boundaries are blurry or, in other words, 'fuzzy.' combination of these two methods can deal with multiple attribute decision-making problems effectively. following are proposed methodologies for evaluation model. For setting up triangular fuzzy AHP hierarchical structure, flood risk evaluation and prediction, issues to be addressed include two aspects: importance ranking of risk indexes, and comprehensive flood risk prediction. To achieve ultimate goal of evaluating ideal comprehensive flood risk, study uses four evaluation criteria and twelve sub-criteria. Based on established hierarchy, comparison matrix of each level be obtained by multiple comparisons between several elements, and relative weight of various factors will be calculated, and finally, total importance ranking of risk factors is calculated.

Findings: In our study, application of a triangular fuzzy AHP approach based on TFN is developed to evaluate flood risk in state caused by major rives like Godavari and Krishna. A hierarchy evaluation index system is established. Four factors & 16 sub-factors included in index system. TFNs are adopted to determine weights of indexes and evaluate flood risk of study area. Flood risk factors ranked, and comprehensive flood risk prediction are determined. Lower regions of Godavai and Krishna rivers then fed into proposed model to evaluate flood risk. Combining fuzzy AHP and TFN, provides a new scientific method for flood risk evaluation and makes evaluation results more reasonable and comprehensive. As evaluation index system developed provides a more reliable reference and evaluation method for flood risk Management.



Significance for practical solutions: Our results may provide government, engineers, analysts, decision makers, and local authorities with a more suitable and invaluable guidance and overview on flooding, which is helpful for them to outline policy and practice of managing flood risk clearly.

ABSSUB-1005

SC 2.6 Comparison of wellbeing and vulnerability approaches for understanding climate change impacts

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Research question: Adaptation to climate change is often aimed at responding to climate change impacts that has been experienced, focusing at current vulnerabilities and risks. A growing body of work is emerging to examine vulnerabilities from a wellbeing perspective. Forward looking adaptation is one of the major agendas in the IPCC 4th Assessment Report which views vulnerability in a sustainable development context.

Vulnerability assessments have considered mainly material and institutional vulnerability with a focus on people's assets and access to resources resulting in a growing understanding of who and what is vulnerable. A three-dimensional wellbeing approach instead shifts the focus from material and institutional vulnerability to include a perspective on looking forward to the aspirations and chosen development pathways.

The aim of this study was to compare the approach of wellbeing versus the approach of vulnerability in understanding climate change impacts and adaptation in the context of drought and floods in Onesi Constituency, Omusati Region, Namibia.

Methodology: The two approaches were tested within a context of one case study carried out in a village in a semi-arid region of Northern Namibia. This study applied a three dimensional wellbeing framework to gain insights into the impacts of drought and floods on the wellbeing of subsistence farmers and a vulnerability approach to understand the impacts of climate change on the livelihoods of the subsistence farmers.

Olwaadhya village in Onesi Constituency was selected as a sampling unit for the study. The village comprises of 67 households. To ensure equal participation in both approaches, the village was stratified into two strata, stratum 1 for vulnerability approach and stratum 2 for wellbeing approach. For the household survey, 20 households were sampled through systematic sampling within each stratum. The rest of the data was collected through focus group discussions disaggregated by age and gender.

Findings: The findings of this study demonstrate that a vulnerability approach provides an understanding on how and why the subsistence farmers are vulnerable to drought and floods while the wellbeing approach provides an understanding on how *'what the farmers have, what they can do with what they have and how they think and feel about what they have and do'* is affected by the impacts of drought and floods.

Significance for practical solutions: These findings have potential for informing adaptation planning. Studying climate change impacts from a wellbeing perspective provides an opportunity that can help address the wellbeing components that people strive to improve.



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SC 2.6 Implications of inherent vulnerability for local adaptation in dryland agro-ecosystems

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Research question: This paper focuses on understanding inherent vulnerability with respect to providing more insight into sustainable rural livelihoods in the light of growing climate variability in dryland agro-ecosystems. The paper focuses on this assessment through the following questions:

1. What are the key factors driving inherent vulnerability of rural dryland communities to climate risks?
2. What are the implications of this inherent vulnerability of drylands for local adaptation to climate variability and climate change in drylands?

Methodology: The methodology is developed in line with a conceptual framework that is underlined by 'vulnerability' as a concept that is inherent to a given dryland agro-ecosystem. The paper proposes conducting a village-level 'Inherent Vulnerability Index' for a rural community by using socio-economic, cultural, biophysical, institutional, livelihood-centred vulnerability parameters. Furthermore, the study focuses on situating this analysis within the varying perspectives of the people directly depending on and therefore impacting the land. To address this complex and multi-faceted problem, it was important to select a study area that well represents the key challenges highlighted by dryland literature. The district of Jodhpur in the western state of Rajasthan, India has been selected for this research.

Findings: Overall, the dependency of local livelihoods on the services provided by ecosystems is greater in drylands than in any other ecosystems, rendering their inhabitants exceptionally vulnerable to land degradation and related resource availability. Growing pressures from population growth, poor human development indicators, increasingly unpredictable climatic conditions and a general lack of investment in drylands, are putting extraordinary strains on the livelihoods of dryland inhabitants and the integrity of their ecosystems, creating difficult land-use management and policy development decisions. Inherent vulnerability, now embedded as a result of externalities, is increasingly driving land-use decisions. Local vulnerability is often expressed through land degradation (as both a cause and consequence).

Significance for practical solutions: One of the world's most overlooked ecosystems, the drylands, has long lived with uncertainty and the threat of unsustainability. Current approaches to managing drylands were found to often fail to produce significant improvements because local knowledge is often undervalued and the complexity of underlying processes is still not well understood. They often lead to reactive risk management research and policy interventions. There is an urgent need to uncover the underlying dynamics and characteristic responses to environmental drivers and human-induced disturbances whilst keeping in mind the vulnerability of these systems to climate variability and change. This is critical for not only conservation/restoration of resources for sustainable rural livelihoods but also the adaptability of the ecosystem to adjust to climate variability and risks.



ABSSUB-834

SC 2.7 How do objective and subjective measures of climate stress influence household migration decisions?

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Research question: What role do proximate and cumulative subjective and objective measures of the environment play in migration decisions among rural households located in resource dependent areas of NE and Central Thailand?

Methodology: I take advantage of the Townsend Thai Data, a unique dataset that annually measures a household's migration activity, income and assets, and access to capital endowments, as well as a household's perceived cause of an income risk. To this rich dataset, I add robust objective environmental data that coincides with the time period of the household survey. Together, this analysis file allows me to model migration as a function of cumulative and proximate measures of objective and perceptual measures of the environment, along with measures captured in the New Economics of Migration and Sustainable Livelihoods Framework.

Findings: I find that exposure to drought or flooding in the year before the survey reduce the odds of a household sending a migration. This might suggest that in the near-term, households are able to adapt locally, or perhaps choose a wait-and-see approach, before deciding to engage in migration in response to the environment. Modelling longer-term, cumulative exposure to the environment also reveals how repeated exposure to a shock influences the decision to migrate. Cumulative exposure to below average environmental conditions reduces odds of migration, but increases the odds of migration when a household's proximate environmental perceptual measure is also considered, suggesting that household's decision to migrate is not based solely on objective environmental conditions. Finally, the odds of a household sending a migrant is influenced by subjective measures of environmental perception, although like the objective measures, follow different patterns depending on proximate and cumulative measures. A household's proximate subjective perception that the environment was a risk to their livelihood reduces the odds of a household sending a migrant. However, as the cumulative number of previous times a household reported an environmental shock increases, so do the odds of a household sending a migrant.

Significance for practical solutions: My initial findings provide some guidance for policymakers who are concerned with the potential for future population displacement under climate change. My work suggests that people are not immediately moving following a deviation from normal environmental conditions, at least not in the case of drought-like conditions. These results challenge assumptions that environmental stress will immediately lead to out-migration. Rather, these assumptions should be reconsidered, particularly in the case of slower-onset environmental shocks where the impact might not be immediately felt. One could assume that people living in areas with frequent drought will adopt a series of adaptation strategies up until a tipping point, when they might be forced to abandon the land and engage in out-migration



ABSSUB-187

SC 2.7 How to encourage farmers to adapt to climate change?

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Research question: Adapting agriculture to climate change is a major challenge, especially in a developing country like India, where more than 80 per cent of farmers are marginal and small farmers whose adaptive capacity is too low. In this circumstance, one cannot expect autonomous adaptation. Even if it were possible, it would not be sufficient to offset losses from climate change. The only way out is planned or policy-driven adaptation, for which the government has to come up with certain policy solutions. What these policy solutions should be is the big question, which is addressed by this paper.

Methodology: To accomplish the above objective, we studied farmers' perception of, and behaviour towards climate change using group information collected from vulnerable farmers located in the eastern part of India, and chosen because it is likely to be severely affected by climate change, being characterized as it is by low per capita income, high population density, and dominance of small and marginal resource-poor farmers.

Findings: Findings indicate that farmers are aware of changes in climate, especially increasing temperature and changing seasonal pattern, and climate change impacts, particularly declining crop productivity, increasing cost of cultivation, and livelihood insecurity. While farming experience seems to be the major factor in farmers' perception of climate change, this study has observed that the print media contributes significantly to such perception. In a wider perspective, the print media can play a significant role in forming perception. However, farmers are doing nothing to deal with it, as is reflected from findings. But they are changing their agriculture and farming practices to deal with socioeconomic changes, and some of these changes – such as changing sowing and harvesting timing, cultivation of crops of short maturity period, intercropping, changing cropping pattern, investment in irrigation, agroforestry – help in adapting agriculture to climate change. So, it may be concluded that farmers are implicitly taking initiatives to adapt climate change. It suggests that farmers have inclination to adapt to climate change. Further, sufficient support systems (e.g. social network effect and collective activity) within the rural setting have been observed that promote farmers adopt new technologies and practices in agriculture. Climate information services and capacity building programme are further suggested to encourage climate change adaptation in agriculture.

Significance for practical solutions: Findings of this study have policy relevance – useful in formulating climate adaptation policy particularly focusing on developing country and resource-poor small and marginal farmers.

ABSSUB-1135

SC 2.7 Gender and adoption of soya bean technologies for climate change adaptation in Northern Benin

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Research question: What are the gender dynamics in the adoption of climate change technologies for soya beans producers?

Methodology: The study was conducted in two rural areas in Northern Benin. These areas have been selected



because of their vulnerability to climate change and the contribution of soya beans to rural livelihood. A multistage purposive sampling procedure with simple random sampling selection have been used to identify farmers. From each area, 150 farmers (75 men and 75 women) have been interviewed. At the end, data were collected from 300 farmers with the use of structured questionnaire. These data involved: the socio-economics characteristics of the farmers, the perception toward climate change, access to resources and extension services.

Both descriptive statistics as well as binary logistic regression have been used to analyse data. Descriptive statistics were used to analyse the socioeconomics characteristics of the respondents. The binary logistic regression was used to access the factors affecting adoption of technologies against climate change. For the purpose of the gender perspective, we separated the regression (men and women). This helped us to find out if the factors that affect the adoption are different from men and women.

Following Gujarati (1988), the model is specified as followed:

$$\ln \{P/(1-P)\} = a_0 + a_1X_1 + a_2X_2 + \dots + a_nX_n + e$$

Where:

P= probability of adoption

a_0 = constant term

(a_1, \dots, a_n) = logistic regression coefficient

(X_1, \dots, X_n) = independent variables

Findings: The results showed that although the producers are aware of the effects of climate change, the resources they have to deal with are still very limited. That is why most of the producers especially women use endogenous knowledge and technology to mitigate the effect of climate change. Although the region face the same problems of climate change, the impact on women and men are not the same. Soya beans producers listed improved technologies and traditional technologies as strategies for climate change adaptation. These technologies are short cycle improved varieties tolerant to drought, endogenous methods, botanical extracts, animal urine and black soap. Majority of women use black soap and botanical extracts because of their low income. Producers are informed on the availability of new seed varieties, but often do not have access to these inputs.

Significance for practical solutions: Keys recommendations:

- Producers Association to design innovations;
- Reduce asymmetric information between actors in disseminating of technologies;
- Create spaces for dialogue, information sharing and strategic debate about adaptive methods to climate change;
- Establish monitoring and Environmental systems Assessment;
- Capacity building of cowpea producers on gender mainstreaming in the technology adoption to climate change.



ABSSUB-647

SC 2.7 Climate-smart agriculture: a systematic review protocol for the scientific basis

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Research question: 'Climate-smart agriculture' (CSA) - food systems that sustainably increase food production, improve adaptive capacity of farming systems, and mitigate climate change when possible - has quickly been integrated into the global development agenda. However, the empirical evidence base for CSA has been scant, complicating its translation from concept to concrete actions on the ground. Thus, there is an urgent need to evaluate current knowledge on the effectiveness of CSA to achieve the benefits it intends and inform discourse on food, agriculture and climate. This systematic review intends to establish the scientific evidence base of CSA to inform the next steps in development programming and policy formulation. This paper evaluates the impact of more than 100 often cited field and farm-level management activities across five categories (agronomy, agroforestry, livestock, postharvest systems, and energy systems) to answer the question of "How do farm-level CSA management practices and technologies affect food production, resilience/adaptive capacity, and climate change mitigation in farming systems of Africa?"

Methodology: The objective of this systematic review is to provide a first appraisal of the evidence for CSA in order to inform subsequent programming. The review is based on data found in English-language peer-reviewed journals with searches using terms relevant to CSA practices and CSA outcomes. Searches were conducted via Web of Science (WoS) and Scopus, and articles located were screened according to predefined eligibility criteria for inclusion in the review. Data capturing the context of the study, management practices, and impacts are compiled in a global data base. Statistical relationships between practices and impacts are evaluated via rigorous meta-analysis methods including response ratios and effect sizes to analyse in detail existing evidence on the three components of CSA.

Findings: The analysis is done at different levels and under different contexts to ensure the usefulness of results under heterogeneous conditions. The meta-analysis is complemented with an analysis of determinants of/barriers to adoption of promising CSA practices covered in the meta-analysis. Main findings indicate that very rarely practices contribute to all 3 pillars of CSA underlining the importance of prioritization in policy making. They also underline the site-specific nature of CSA and provide caution in using the CSA label for field and farm level practices.

Significance for practical solutions: Given the high profile of CSA in the global climate change and food security agenda, and the dearth of scientific evidence to support it, this paper contributes to the literature by providing the most comprehensive database and meta-analysis to date, as well as to the development community at large by bringing evidence to the table to improve effective policy making on food security and agriculture under climate change. It also serves to identify knowledge gaps and uncertainties to inform future scientific agenda.



ABSSUB-934

SC 2.7 Climate risks, food insecurity and livelihood responses: why gender matters?

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Research question: Climate risks and shocks entail short-term food shortages and insecurity, but also set in motion a process of medium and longer term adaptation and response in terms of changes in cropping patterns and land use, and the diversification of livelihoods. These processes are highly gendered, and vary across wealth, age and status groups. They may enhance seasonal workloads, and hunger, for some women, with implications not just for the women's own health and nutrition, but equally the work and wellbeing of young children, adolescents and other adults. This paper seeks to answer the question: Why and in what ways does gender matter in responding to food insecurity triggered by climate risks?

Methodology: The paper is based on empirical work in Eastern India using mixed methods. In the first instance, a baseline survey of 150 households across five villages, representing different ethnic/caste categories and wealth statuses, was conducted. Following a preliminary analysis of the data, households were further categorised according to their nutritional and food security, and land-holding status. 30 households were selected for in-depth qualitative interviews. Both men and women in households were interviewed separately to understand their work and food strategies, including farm and non-farm work, as well as collection of wild foods, maintenance of small livestock and domestic and reproductive work. SPSS and NVIVO are being used for analysing the data.

Findings: Using an intersectional approach, the paper finds differences in responses to shifting climatic conditions on the rural household economy, based on caste/ethnicity of the household, as well as amount of land owned and cultivated. In the first instances, upwardly mobile caste/ethnic groups are adopting a range of social practices that limit women's mobility outside the home, but also change food practices, denying them essential proteins. The problem for the lower caste groups is reverse - higher work burdens and less of food to eat. In terms of land-owning groups, one strategy is the shift to commercial tree crops like eucalyptus, which has a monetary value, but the returns are received once in five years, and mainly by the men. this replaces women's millet and vegetable crops.

Significance for practical solutions: The study is significant in unpacking how differentiated livelihood responses in a context of adaptation to climate risk affect gender relations in different ways. It is important to understand these directions of change in order to ensure food security and improved health and wellbeing for all members of the community.



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SC 2.8 ADAPTING CROPPING SYSTEMS TO A CO₂ RICH ATMOSPHERE OPPORTUNITIES AND CHALLENGES FOR FOOD AND WATER SECURITY

ABSSUB-634

SC 2.8 Regional disparities in the beneficial effects of rising CO₂ emissions on crop water productivity

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Research question: Research indicates unabated climate change will exacerbate water scarcity around the world. This is thought to threaten agricultural productivity and food security especially in arid regions, where agriculture relies heavily on irrigation and consumes the majority of diverted freshwater. Yet, rising atmospheric CO₂ concentrations ([CO₂]), despite directly contributing to climate change, have the potential to increase crop water productivity (CWP, the ratio of crop yield to transpiration) as it enhances photosynthesis and reduces leaf-level transpiration of plants. Although these dual effects on crops have been widely studied, uncertainties remain substantial and best adaptation strategies accounting for CO₂ have yet to be developed.

Methodology: Here we present results from networks of field experiments and global crop models focusing on the role of CO₂ on CWP for maize, rice, soybean and wheat and evaluate the implication of several adaptation measures such as irrigation, switch of crop cultivars and fertiliser application for food and water security.

Findings: Results from observations and global crop models indicate CO₂ effects could increase global average CWP by up to 8-25% by the 2080s depending on crop types, with particularly large increases in arid regions and for well-fertilised crops. If realized in the fields, the effects of elevated [CO₂] could considerably reduce crop yield losses and agricultural consumptive water use. We identify regional disparities driven by differences in growing conditions across agro-ecosystems that hint at potential strategies for increasing food production without compromising water security. As well, increasing nitrogen fertiliser application in some low N-input cropland could not only increase crop yield but also mitigate the carbon-nitrogen ratio unbalance expected with rising [CO₂].

Significance for practical solutions: This presentation will provide the scientific basis for initiating important research collaboration designed to better understand the role of CO₂ on different cropping systems in the world. Practical solutions for adapting to climate change must account for the role of CO₂ and thus major advances in our understanding of crop-CO₂ interaction in the field are urgently needed.



ABSSUB-1372

SC 2.8 New development of FACE experiments and consequence for adaptation futures

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Research question: The atmospheric concentration of CO₂ ([CO₂]) is a key determinant of crop productivity, as well as crop resource use efficiency and stress tolerance. While agriculture has recognized and acted on the need to adapt crops to heat and drought for millennia, it has only been recently recognized that intervention is needed to adapt crops by breeding or biotechnology for optimal performance in future, elevated [CO₂]. This work aims to identify targets for crop adaptation to elevated [CO₂] through both genetic and trait-based approaches.

Methodology: Here we present results from a global network of Free-Air CO₂ Enrichment (FACE) experiments where the world's major crops (including maize, wheat, rice and soybean) have been grown at elevated [CO₂] in unperturbed field conditions at locations in their primary regions of production. Agronomic, physiological, molecular and genetic analyses have been applied to identify targets for crop adaptation to elevated [CO₂].

Findings: Experimental data indicate there is significant potential for improving crop performance in the elevated [CO₂] that will occur by the mid-21st century. These gains could be achieved by traditional breeding that exploits genotypic variation in sensitivity to elevated [CO₂], which has been identified within germplasm of all the world's major crops. In addition, further gains could be achieved by exploiting biotechnological approaches to manipulate traits that limit yield quantity and quality under elevated [CO₂]. Targets include, seed iron and zinc content, stomatal conductance, Rubisco kinetics, phloem loading and root architecture.

Significance for practical solutions: This work provides the fundamental knowledge required to motivate and guide crop improvement organisations and industry to employ breeding and biotechnology to produce a new generation of crops adapted to elevated [CO₂] and capable of counteracting yield losses to rising heat and drought in the 21st century.

ABSSUB-1240

SC 2.8 Narrowing CO₂ uncertainty in projections of climate change impacts and adaptation

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Research question: Although the number of studies investigating responses to CO₂ enrichment (particularly in the field) is limited in relation to the range of edapho-climatic conditions at which crops are grown, consensus exists on the mechanisms through which C3 and C4 crops respond to CO₂ enrichment. Uncertainty in CO₂ response, however, remains high. We present two case studies where we address two questions: (1) what is



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the relative importance of CO₂ response as a source of uncertainty for C3 (groundnut) and C4 (maize) crops?; and (2) what are plausible avenues to reduce this uncertainty?

Methodology: For a C3 crop (groundnut) in India, we develop an ensemble of crop simulations for historical and future climates based on the GLAM model. We use the ensemble of runs to quantify the potential impact of genotypic adaptation, as well as to partition uncertainty and explicitly quantify robustness (i.e. signal-to-noise). For a C4 crop (maize), we first challenge the view that experimental observations (field vs. chamber) present large discrepancies by means of a meta-analysis. We analyse response ratios (RRs) for yield and biomass, photosynthesis (A), stomatal conductance (g_s), transpiration (E), and water-use efficiency (WUE). We then analyse how crop models simulate responses to CO₂ across environments, and quantify the contribution of CO₂ response to total yield change uncertainty in a set of global gridded simulations. By analysing both data and model simulations we construct a potential pathway to reduce uncertainty and improve model representation of CO₂ response.

Findings: Our case study for Indian groundnut demonstrates that, firstly, CO₂ response is the least significant source of uncertainty (only 5-15 % of the total uncertainty) in the simulations of adaptation. Secondly, we find that despite uncertainty, robust projections of the benefit of adaptation are possible in ~80 % of cropping areas. The maize meta-analysis revealed that uncertainty in CO₂ stimulation in maize is mostly due to data paucity rather than to disagreement between FACE and non-FACE settings. AgGRID model results showed that models differ in their responses to CO₂ enrichment and that some models (but not all) do not simulate the expected zero (or near-zero) stimulation in wet environments. Findings suggest that some models do not account for CO₂ response for the right reasons, although further research is needed to assess responses against experimental data.

Significance for practical solutions: We argue that in order to reduce uncertainty in CO₂ response better study designs that quantify CO₂-response parameter uncertainty are needed. Our framework to quantify and partition uncertainty and assess robustness could help determining where and how uncertainties can be reduced to enhance projection robustness. Further research is also needed to incorporate the latest knowledge and data into state-of-the-art crop simulation models. This will ultimately lead to improved adaptation planning.

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SC 2.9 AgMIP coordinated global and regional integrated assessments of climate change and food security

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Research question: How can we provide stakeholders with more consistent and credible information on which to base adaptation and mitigation policy decisions in agriculture, bring agricultural modelling up to the same standards of global climate models and integrated assessment models (e.g., ensemble approaches, data and IT, scenario design), and overcome scale and disciplinary constraints.

Methodology: The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modelling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate

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impact projections for the agricultural sector. Currently, AgMIP has nearly 800 participants from more than 45 countries contributing their expertise to over 30 projects and activities.

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. The proposed AgMIP Coordinated Global and Regional Integrated Assessments of Climate Change and Food Security (the AgMIP CGRA) will link site-based crop and livestock models with similar models run on global grids, and then will link these biophysical components with economics models at regional and global scales. The multi-model, multi-disciplinary, multi-scale integrated assessment framework will be used to investigate climate change impacts on agriculture and food security under various scenarios of economic development, adaptation, mitigation, food policy, and food security. These coordinated assessments will be grounded in the expertise of AgMIP partners around the world, leading to more consistent results and messages for stakeholders, policymakers, and the scientific community. The early inclusion of nutrition and food security experts has helped to ensure that assessment outputs include important metrics upon which investment and policy decisions may be based.

Findings: This presentation will provide an overview of the planned AgMIP CGRA and will describe opportunities for participation and collaboration. The CGRA builds upon existing AgMIP research groups (e.g., the AgMIP Wheat Team and the AgMIP Global Gridded Crop Modelling Initiative; GGCMi) and regional programmes (e.g., AgMIP Regional Teams in Sub-Saharan Africa and South Asia), with new protocols for cross-scale and cross-disciplinary linkages to ensure the propagation of expert judgment and consistent assumptions.

Significance for practical solutions: The CGRA is building partnerships in order to produce a major new assessment to inform the 6th Assessment Report of the Intergovernmental Panel on Climate Change. Participation is welcomed in disciplines and regional teams that are forming now.



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SC 2.9 Global economic models: up- and downstream linkages

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4 LEI, Wageningen, the Hague, Netherlands,

5 IPTS, European Commission, Sevilla, Spain

Research question: Climate change is having significant impacts on human and earth systems. The purpose of the global economic models is to evaluate the likely impacts of climate change on the global economy. The focus of the research in the context of AgMIP is on agriculture. Thus, what impacts will climate change have on crop yields and livestock productivity? How will this effect land-use? Which countries will feel the greatest impact? How will this affect farm livelihoods, particularly poor farmers? How with the urban poor fare? In a globalized world, what is the role of price transmission? Will trade ease the adjustment for countries hit by production shortfalls? How much can agriculture adapt, and at what cost?

Methodology: AgMIP's global economic modelling team is composed of 10+ modelling teams from around the world. Teams are divided into two broad groups – partial equilibrium models that focus largely on agriculture and general equilibrium models that encompass economy-wide interactions, for example labor markets and agriculture. The modelling groups have agreed to harmonize on some key scenario drivers: population and income growth and autonomous yield improvements.

One of the key features of AgMIP are the up- and downstream linkages. The main upstream linkages are the yield shocks generated by the global gridded crop models that are impacted by the GCM driven climate shocks. The downstream linkages are used by economic models that operate on a smaller scale—a country, a sub-region within a country, or even the district or village level. The regional models take some key signals from the global models such as changes in prices and trade. This inter-operability across disciplines is necessary to understand the full complexity of how climate change will affect human systems.

Findings: Phase 1 of the AgMIP project led to a special issue of *Agricultural Economics* (2014, Vol. 45). The models exhibited a wide range of outcomes despite the harmonization. For example, in the absence of climate change, agricultural prices vary between -20 and +40 percent between 2010 and 2050. The models were in relative agreement regarding future demand for agriculture, but differed more widely on how it would be produced – with different land-use implications. The team is now working on expanding the agricultural storylines of the shared socio-economic pathways that will inform the next climate change assessment report and assist more broadly in identifying policies to deal with climate change.

Significance for practical solutions: Agriculture is the most sensitive economic sector to climate change. Even if on a global level the world can cope with modest climate change, this may prove more difficult in some regions that will be more deeply affected and where the number of vulnerable is high – such as Sub-Saharan Africa and South Asia. An outcome of this work is to identify hotspots and policies to adapt to a changing world.



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SC 2.9 Interactions of Mean Climate Change and Climate Variability Increase Risk of Food Security Extremes

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Research question: Climate change's impact on the future of agricultural systems around the world will depend on the resilience of each farming system as well as the types of climate shifts that affect a given region. A large percentage of studies examining climate change impacts have focused on the role that changes in mean climate will have on agricultural production, finding the potential for worrying damages and shortfalls. Climate change, however, will also interact with climate variability to alter the distribution of extreme events that lead to food insecurity. This study explores the following research questions:

- 1) *How will mean climate change and climate variability interact in future decades?*
- 2) *Are farming systems more resilient to mean climate changes than to shifts in extreme events?*
- 3) *What types of farming systems are most vulnerable to these climate changes?*

Methodology: The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a network of the 800+ climate, crop, livestock, economics, and food security experts engaged in cutting-edge research to understand the multi-scale and multi-disciplinary climate change impacts on agriculture and global food security. AgMIP's Coordinated Climate-Crop Modelling Project (C3MP) conducted a common set of sensitivity tests on 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. Sensitivity test results allow for analysis of impacts response surfaces that can be quantified for specific crop species or vulnerable regions, as well as responses to mean conditions as different from responses to extreme seasons (e.g., hot/dry, cool/wet).

Findings: Climate change can alter the distribution of agricultural outcomes simply by shifting the mean temperature, rainfall, and carbon dioxide concentration in a growing season, often leading to an increase in extreme events as biophysical thresholds are exceeded more frequently. Shifts in climate variability can conversely alter the average yields, as farms tend to perform best when conditions are in the central range of expectations rather than being extreme in some way. Finally, climate change and climate variability can interact to increase the number of extreme events and also the proximity to damaging thresholds, leading to more severe impacts and vulnerability in agricultural economies and food systems.

Significance for practical solutions: Future food systems will need to be resilient to the long-term shifts in climate, but also the extreme events that will affect us as these slow changes manifest. These extreme events are potential drivers of food insecurity, economic loss, and societal strife, and it is therefore important that we understand the potential scope of future challenges. With such knowledge the food system can build a more resilient future that is prepared for altered probabilities of extreme events and resulting food insecurity.



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SC 2.10 Integrated assessment of climate change mitigation and adaptation trade-offs in Austria

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Research question: In this article, the trade-offs between mitigation and adaptation policies are analyzed.

Methodology: We apply an integrated modelling framework (IMF) to quantify climate change impacts as well as mitigation and adaptation policies. The model is applied on two contrasting Austrian case study landscapes dominated by either grassland or cropland. Indicators describe impacts on the abiotic and biotic environment as well as landscape appearance. Results show that the impacts on farm gross margins and the abiotic and biotic environment are substantial either directly from climate change (e.g. changing erosion levels) or triggered via adaptation responses (i.e. land use and management change). Average gross margins increase between 1% and 10% in the cropland dominated case study landscape, depending on the climate change scenario and the policy scenario. With respect to biodiversity indicators, land use changes in the mitigation scenario decrease vascular plant species diversity on farmland by 3% to 5%. These changes are driven by policies to reduce land use intensity. However, the adaptation policy scenario decreases species diversity due to more intensive land use such as increasing fertilizer application rates.

Findings: Results indicate the effectiveness of climate change adaptation in increasing farm incomes but also show the need to coordinate mitigation and adaptation policies in order to balance farm income changes and environmental outcomes. The IMF reveals considerable heterogeneity of climate change and policy impacts among farms and regions and is able to indicate trade-offs among adaptation and mitigation policies.

Significance for practical solutions: Climate change poses fundamental challenges on the society including different economic sectors such as agriculture. Agriculture contributes to global warming and therefore offers mitigation opportunities. Policies are implemented to reduce green-house gas emissions and increase organic carbon storage. However, climate change also triggers autonomous adaptation responses of farmers and thereby can impact the success of climate change mitigation.

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SC 2.10 More strategic farm management needed to adapt to climate change in the North Savo region

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Research question: The region, located in middle part of Finland, covers 10% of milk and beef produced in the whole country. Dairy and beef production manage 2/3 of the agricultural land and produce >70% of the value of agricultural production in the region. Climate change implies higher temperatures and precipitation in the

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North Savo region. Average temperature is expected to increase by +3-9 °C in winter and +1-5 °C in summer time until 2100, depending on the climate scenario. Annual precipitation is expected to increase (from the level of appr. 700 mm/year) by +12 - 22%, but relatively more in winter time (+10-40%) than in summer (+0-20%). Probability of early summer droughts, more heavy rains and exceptionally wet conditions during the growing period, are expected to increase. They are likely to cause problems for farmers since timeliness costs are already high due to short time-windows for sowing and harvesting. Nevertheless, effective temperature sum is expected to increase considerably which is expected to provide benefits. What is needed to cope with the problems and utilise opportunities in the long run?

Methodology: The methods used in the study include soil and crop level analysis and simulation modelling, as well as economic modelling at farm and sector levels. Stakeholder views were taken into account in identifying options to be analysed and interpretation of the results.

Findings: Results suggest that new cultivars and their improved management may maintain cereals yields despite the problems, and improve grass yields up to 2050. However, any significant increase in crop productivity requires increased or changed fertilisation, changed crop rotation, or increased crop protection and liming. The implied costs need to be covered primarily by prices of agricultural products. The realization of the future crop yields and economic gains were found to be strongly dependent on future market and policy conditions. Large specialised farms see current policies more suited for part-time producers and not encouraging for long-term development of production, including adaptation to climate change. The results suggest that current high production costs make significant increases (>10%) in the agricultural production, even though possible at individual farms, unlikely in the aggregate.

Significance for practical solutions: Increasing yields may result in efficiency gains, e.g. reduced costs related to logistics and drought risk management. Our results show the importance of long-term strategic management in the context of the following climate related problems, partly experienced at farms already: Increasing variability of crop yields, more frequent wet conditions and drought/heat spells, winter time damages of forage crops and winter cereals (ice encasement, flooding, frost), increasing plant disease pressure, and soil compaction. Some spontaneous adaptation has taken place already, e.g. use of light weight machinery, despite implied costs.

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SC 2.10 Winners and losers from climate change in agriculture: a case study in the Mediterranean basin

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Research question: The analysis reconstructs the effects of inter-annual climate variability, and then of its changes, in a diversified farming district that represents a wide range of rainfed and irrigated agricultural systems in the Mediterranean area.

Methodology: Based on agro-climatic data generated by a Regional Atmospheric Modelling System, and by calibrated crop and livestock models, we estimated the agricultural productive responses in the form of probability distribution functions (PDFs) under current and future climatic conditions. We used these PDFs to



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represent the expectations of farmers in a discrete stochastic programming model that reproduced economic behavior under uncertainty conditions. By comparing the results obtained in the two scenarios we evaluated the impact of CC, also considering the adjustment possibility allowed by current technology, and price regimes and policy. The response is provided for the entire study area and for the single farm typologies operating in it.

Findings: Major differences emerged among the impacts on the farm typologies and sub-zones of the study area. Crucial differences depend on water availability, since only irrigated C3 crops took full advantage from the fertilization effect of increasing atmospheric CO₂ concentration. Rainfed crop production was depressed by the expected reduction of spring rainfall associated to the higher temperatures. So, a dualism emerges between the smaller impact on crop production in the irrigated plain sub-zone, equipped with collective water networks and abundant irrigation resources, and the major negative impact in the hilly area, where these facilities and resources are absent. However intensive dairy farming was also negatively affected in terms of milk production and quality, and cattle mortality because of the increasing summer temperatures. This provides explicit guidance for addressing strategic adaptation policies to CC in the Mediterranean zone. It can also be used to help farmers in developing awareness of phenomena that are already in progress, which is a prerequisite for effective adaptation responses.

Significance for practical solutions: Inter-annual variability in seasonal weather is typical of the Mediterranean region and has always created uncertainty in decisional processes of cultivation and livestock breeding. This should not be neglected when assessing the impact of climate change (CC), which modifies the atmospheric variability and generates new uncertainty conditions. A fortiori, this applies when modelling the adaptive responses of farmers and policies that should support.

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SC 2.10 Adaptation of European dairy farms to climate change: a case study approach

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Research question: Assess for four case study dairy farms; one from each of Ireland, the Netherlands, France and Italy the top four adaptation options for each system. For each adaptation measure, the major climate impact has also been identified. These assessments were based on expert opinion.

Methodology: The impact of climate change on livestock production systems will vary with livestock type, system design and local conditions. These effects are direct through impacts on animal performance and indirect through effects on crop and grass production and quality. Adaptation can be categorized in three main categories: feed production, feed supply (feeding) and livestock.

Findings: The results for the Ireland and the Dutch case studies indicate that in both systems water management, and increases in fertilisation rate and supplemental feeding are the chosen adaptations for drought, extended season, and issues concerned with extreme events, respectively. In addition, the Irish have also identified that animal breeding is an appropriate adaptation option for extreme events and waterlogging whereas the Dutch perceive that heat stress will be a risk and thus cooling of animals may be required. In the Italian case study, the climate impact to which the farmers will have to adapt is drought. The preferred

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adaptations are feed storage, irrigation use of mixtures of plant species and supplemental feeding. In France, the climate impact is perceived to be due to drought, extreme events, heat stress and the extended growing season. In this case, the adaptations identified were water storage and irrigation, conservation of feed as buffer, cooling of animal housing and cover crops. In Northern Europe there is clearly concern regarding the impact of extreme events, although they are likely to benefit from the extended growing season. In Southern Europe, the adaptation measures are focusing on the risk of drought and increases in temperature reducing production. However, in terms of agriculture, as there is a need to reduce greenhouse gas emissions from the sector, it is important to consider the synergies and trade-offs of the adaptation measures with the mitigation measures. This is illustrated by the choice of increasing fertilisation rate by the Irish and Dutch case study, which would have the effect of increasing greenhouse gas emissions. These case study farms clearly show that impacts and therefore the most appropriate adaptation will vary across Europe.

Significance for practical solutions: Adaptation of the agricultural sector to climate change is required in order that industry remains productive and profitable. The projected impacts of climate change and the effect this will have in agriculture will differ across Europe, with Northern European countries expected to benefit from the more favourable conditions, whereas in Southern Europe, drought is likely to become a big issue in terms of productivity.



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SC 2.10 Design future climate-resilient barley cultivars using crop model ensembles

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(See list at the end)³

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Research question: Our study aims to: (i) examine the main limitations of crop simulation modelling for ideotype breeding, (ii) present a new approach developed in MACSUR (<http://macsur.eu/>) Barley Cultivar Design (BCD) study, and (iii) present results on model-aided ideotyping of climate-resilient barley cultivars for Boreal and Mediterranean climatic zones.

Methodology: The study suggests that process-based crop models should be an important tool for evaluating new cultivars and supporting crop breeding. Combining conventional crop simulation with genetic modelling promises to accelerate delivery of future cereal cultivars for different environments. Robustness of model-aided ideotype design can further be enhanced through continuously improving simulation models to better simulate interactions between genotype, environment and management, better capture effects of climate extremes and the use of multi-model ensembles.

Findings: The results showed that some genotype (represented by a set of genotypic parameters in crop model) are promising under future climate change conditions, resulting in high yielding and low variability, however some could lose yields substantially.

Furthermore, traits such as long reproductive growing period, 'staying green', high light use efficiency or photosynthesis rate, drought- and heat- resistance are desirable under future climate conditions, which can produce substantially positive impacts on yields under contrasting conditions. However, some traits such as crop development rate during vegetative growth stage and maximum leaf area index had different impacts on crop yields under different climate conditions. The favorable ideotype was further proposed with combinations of several key genetic traits.

Significance for practical solutions: The global demand for agricultural crop production is expected to roughly double by 2050. However, climate change and climate extremes exacerbate the constraints on increasing food supplies and food security. Yields for important crops have been stagnating in several important agricultural regions around the world due to changes in climate and agronomic management. Cultivar development and improved agronomic practices are a center piece of climate change adaptation in agriculture. Process-based crop models developed for simulating interactions between genotype, environment and management are widely applied to assess impacts of environmental change on crop development and growth, and grain yield formation, as well as to design adaptation strategies. During recent decades, crop model has become an important tool for evaluating new cultivars and supporting plant breeding, in particular in the design of ideotypes, i.e. "model plants", for different crops and cultivation environments.

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SC 3.1 Water security and climate change: an evolving research agenda

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Research question: Climate change will have far reaching consequences for water resources across all dimensions of water security, particularly through changing frequency and intensity of extreme weather events such as floods and droughts. The paper examines developments and key themes in research on climate change and water resources during the last three decades.

Methodology: This paper reviews IPCC report chapters on water resources and academic literature on water security and climate change.

Findings: Since the IPCC was established, five major assessments have been published, and climate change has moved from a specialist area of research to a leading international focal point of global research and policy. Water as a global issue has seen the launch of a plethora of agencies and international conferences, framed around contested notions of a global water crisis, with many players now advocating water's centrality in our response to climate change. The review traces a shift in focus from climate impacts to broader management and policy concerns addressing the need for adaptation and greater relevance for societal decision-making. The main conclusions and knowledge gaps identified in successive IPCC chapters are fairly stable over time; emerging issues include evidence of adaptation and the potential need to adapt to the consequences of mitigation policy.

During the last decade research effort has grown substantially and developed specific issues in more detail, often involving greater technical complexity. Key themes include: downscaling climate scenarios; attempts to characterize uncertainty; addressing the implications of uncertainty for decision-making; integrated assessments; and case studies coupling understanding of climate change impacts within a broader context of policy, management and decision-making.

Significance for practical solutions: Reflecting on these themes suggests there has been a tendency to problematise the issue of climate change for water resources management, which has highlighted challenges, rather than identifying responses. Uncertainty - how to characterize it and how to deal with it - remains a defining feature of research on adaptation and water. Adaptation in practice will likely require a blend of approaches, based on their strengths and weaknesses, in relation to the technical challenge and societal values about wider framings of water security. The paper concludes by outlining several practical directions for future research.



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SC 3.1 Regional headwater governance in Himalaya for water security in South Asia under climate change

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Research question: Himalaya constitutes headwaters of some of the largest trans-boundary basins of planet. Ecosystem services, particularly freshwater flowing down from Himalaya sustain one-fourth global population dependent primarily on subsistence agriculture in South Asia. Climate change has stressed hydrological regimes of Himalayan headwaters through higher mean temperatures, melting of glaciers, rainfall variability and increased frequency of extreme weather events causing substantial decrease in water availability; and consequently, increasing proportion of water, food, and livelihood insecure population in South Asia. A coordinated regional adaptation framework is therefore highly imperative not only for responding to long-term impacts of climate change and achieving water, food and livelihood security, but also for attaining post 2015 Sustainable Developments Goals.

Methodology: Study aims at evolving a coordinated regional trans-boundary headwater governance framework underlining role and critical significance of Hindu Kush Himalayan (HKH) ecosystem services in sustaining food, water, and energy security in South Asia under climate change. Methodology included: (i) analysis of mutual environmental and economic benefits of integrated trans-boundary headwater management; (ii) appraisal of reasons and rationale for missing regional cooperation; (iii) assessment of geo-political constraints in initiating effective regional cooperation dialogue; and (iv) evolving an institutional framework for trans-boundary headwater governance.

Findings: Study revealed despite geographical and cultural contiguity South Asia is one of the most disintegrated regions characterised by political tensions, armed conflict, and extreme political instability and economic imbalances. It was observed 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. Further, results clearly indicated that issues and challenges in food, water, and energy sectors are interlinked in several complex ways and cannot be managed effectively without cross-sectoral integration and regional cooperation. Study also identified a range of important potential benefits of regional headwater cooperation including: (a) sharing information and developing integrated flood forecasting and early warning system, (b) storing water in upstream river basins for flood moderation and increasing flow in dry seasons, (c) harnessing water resources to generate hydroelectricity, and (f) managing watersheds for increasing availability and access to water both in up-streams and down-streams.

Significance for practical solutions: Outcomes of study would help reducing vulnerability of one-third global population to climate change; improve water, food and livelihood security of some of the poorest people of the world; and improve response mechanism of riparian countries to climate change induced natural risks.



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SC 3.1 Hotspots of climate change-enhanced conflict risks

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Research question: The main research question the research aims to answer is whether and where climate change can lead to increased international migration in the future as a result of conflicts. Three sub questions are identified: 1) Under what circumstances may water scarcity lead to internal conflict and international migration? 2) How may water scarcity change in future and what is the role of climate change in this? 3) Where can increased climate change and related increases in water scarcity lead to a higher risk of internal conflict and international migration?

Methodology: Research question 1 is answered based on literature analysis leading to a causal model of circumstances leading to conflict risk. Research question 2 is answered by simulating the global water balance model PCRGLOB-WB for different climate change (RCPs) and socio-economic (SSPs) scenarios. The results from research questions 1 and 2 are combined to first test the extent to which current conflict and migration can be explained and subsequently to assess where future hotspots of conflict risk and migration may be found.

Findings: The research results give insight in the role of climate change and water scarcity in internal conflict and international migration and where such risks may increase in future.

Significance for practical solutions: Increased water scarcity as a result of climate change and other factors can have both local and global implications when they lead to conflict and international migration. Understanding conflict and migration risks in relation to water scarcity and climate change is important to guide efforts on climate adaptation to reduce the consequences of changes in water availability.

ABSSUB-1054

SC 3.1 Using a novel climate – water conflict vulnerability index to capture double exposures in Lake Chad

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Research question: In this paper, I seek to pin down why there are differences in the vulnerabilities of farming, fishing and pastoral livelihoods to climate variability and water conflict in Lake Chad; whether and how the determinants of vulnerability can be useful in understanding climate and water conflict interactions; and how a climate-conflict linked context in which vulnerability is experienced can inform interventions to reduce vulnerability in conflict-prone, water scarce environments.

Methodology: I develop a composite climate-water conflict vulnerability index (CWCVI) based on a double exposure framework derived from advances in vulnerability assessments. The CWCVI approach involves schemes for selecting, validating, standardising and weighing indicators drawing on a mix of expert views and livelihood theories. The approach resonates with climate conflict perspectives and uses a normative framing consistent with the context, place and time specific nature of both adaptation and vulnerability analyses. The



CWCVI was populated with data obtained through surveys of 240 resource users in 7 villages on the south-eastern shores of Lake Chad. Data captured exposure, sensitivity and adaptive capacity variables. Analysis was conducted at the household level and later aggregated to obtain information on different sub-groups. Data were coded and analysed using SPSS v21.

Findings: Pastoralists were more vulnerable in terms of climate-structured aggressive behaviour within a lake-based livelihoods context where all resource user groups show similar levels of exposure to climate variability. They have limited social networks and livelihood income strategies, and their migratory lifestyle often pitched them against other water resource users. 'Views from the vulnerable' indicate that water conflict is likely to have contributed more to double exposure than climate variability, and that farmers may be more exposed to the double (combined) effects of climate variability and water conflict. Further, findings suggest that besides the usefulness of the CWCVI in informing climate conflict thinking, it can provide the basis for climate conflict causality analysis. It privileges the directionality of vulnerability by focusing on the usefulness of the vulnerability lens over resource scarcity in operationalising climate-water conflict relations for lake-dependent environment.

Significance for practical solutions: Our approach can be used to understand the human and environmental security components of vulnerability to climate change, and to explore ways in which conflict-structured climate adaptation and climate-sensitive conflict management strategies can be integrated to reduce the vulnerability of populations in high-risk, conflict-prone, water scarce environments.

ABSSUB-274

SC 3.2 Water sector adaptations for hydraulic fracturing in Texas

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Research question: Shale gas and oil production are on the rise in the United States. While the increase in shale gas production is reducing the overall greenhouse gas (GHG) emissions of the United States, because it is replacing coal usage, shale gas production is a water and energy intensive process. This study focuses on Barnett shale play in Texas, which draws most of its water needs from groundwater, which is also the primary source for drinking water in many counties. The study estimates the life cycle water consumption and the life cycle global warming potential (GWP) of the production of Barnett shale gas in Texas.

Methodology: This life cycle assessment is done for a shale gas well, from its construction to the end of life, in SimaPro LCA tool. The life cycle GWP are assessed using EPA's TRACI model. The water consumption index is calculated using the Hoekstra et al. 2012 water scarcity method. The contribution of shale gas production to GHG emissions and water scarcity is assessed based on four water management scenarios for Barnett shale including a) business as usual which entails direct water reuse, treatment at a municipality, and deep well injection; b) complete underground injection; c) partial desalination and direct reuse; and d) complete



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desalination and reuse. These results are combined with regional socioeconomic scenarios to assess future risks and to inform policies for enhancing the adaptive capacity of the water sector in Texas.

Findings: Significant water savings can be achieved by investing in desalination and treatment of flow back and produced water from fracking activities. However the GWP of the extraction process remains the same albeit slightly different for each wastewater scenario. Each scenario presents a trade-off between the water footprint and the GWP based on the underlying assumptions with regard to the life cycle of the extraction process. The outcomes are also sensitive to the prevailing climate conditions, water policies, and socioeconomic conditions. These trade-offs are subject to change with time and are dictated by the climate and socioeconomic environment of the future, which is explored within the disparate futures scenarios framework.

Significance for practical solutions: The future is likely to see increasing concerns about sustainability of the water sector given increasing population and demand for domestic water use, economic pressures associated with enhancing shale gas production in the country, and climate change risks to water resource availability. A set of regional storylines has been developed with disparate development scenarios for the South-eastern region, which possess information on future projections of energy and water sectors, and details on policy and governance of each sector. These storylines are used in conjunction with the results from the LCA analysis, to inform alternate water policies that can be implemented to enhance the adaptive capacity of shale gas production in ways that are more sustainable.

ABSSUB-550

SC 3.2 Guidelines to assess sustainable production limits for irrigated agriculture: Letaba Subbasin (SA)

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Research question: The world's food systems and water resources are under increasing strain as a result of a growing world population and climate change. Any local extension of irrigated agriculture in an arid river basin may potentially restrict the possibility to extend water use at another location. We define *Sustainable production limits* as limits for the possible resource use, within which a production can be extended without restricting the growth opportunities at a neighbored location, also in view of the long-term future (climate change). Interventions affecting land and water use, depend for a large part on, for example, entrepreneurial initiatives. Such variables cannot be included in quantitative deterministic models. Furthermore for the upscaling – downscaling of local interventions it is important to reduce complexity. Interactive IT tools may enable involved actors to switch between relevant knowledge about resources at operational level and strategic planning scale. In this research project 'guiding principles' were identified (research objective) to combine deterministic scenario approaches with participatory scenario building and interactive IT tools.

Methodology: The research is underpinned with the results of a case study in South Africa, the Letaba sub-basin, part of the Limpopo River Basin. In this area interventions and innovations are under consideration to increase agricultural production and livelihood at smallholder farms under water scarce conditions. Possible uncertainties and discrepancies between theoretically plausible and actually realistic and sustainable



expansion of irrigated agriculture were illustrated with scenario's.

Findings: If we use the water balances as a proxy for SPL's at operational scale and strategic planning scale (basin, sub-basin) we conclude that theoretical scenarios are plausible in which 3000 – 6000 ha irrigation schemes within the Letaba sub-basin can be revitalised in prospect of future additional water supply and current environmental water requirements (Kruger park). When climate change and local socio-economic conditions, such as market access, energy costs and global macro-economic developments are taken into account the area where revitalisation of irrigation schemes is feasible becomes smaller (not quantifiable), but probably also more realistic.

Expert rules at multiple scales about SPL's such as water supply, water requirements and market access are necessary to make the solution space spatially explicit and to be able to anticipate on future water requirements. Not only the water and agricultural sector are important stakeholders to determine SPL's but also retailers, food industry and the consumers.

Significance for practical solutions: The guiding principles are useful for water managers in arid zones where extension of irrigated agriculture is under consideration.

ABSSUB-604

SC 3.2 Establishing a water sharing mechanism at local level in Vietnam

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Research question: The inadequacy of fresh water resources for agriculture is an important problem which is expected to increase in light of climate change and expected increase of drought. Sustainable solutions are required, which consider the sustainable use of fresh water resources, equitable distribution, and the livelihood of the farmers now and in the future. In Vietnam, agricultural developments have contributed tremendously to improved living conditions. However, farmers experience water shortage, and while a water resource management policy is in place at national level, it has not yet been operationalized at local level. The farmers in the province of Quang Nam experience such fresh water shortage in the cultivation of paddy in the summer-autumn season. Conflicts arise at commune and district level regarding the sharing of the water between different users, and some farmers turned to other crops. The water shortage is expected to increase in future, also taking climate change into account.

Methodology: In a participatory action research, the problem was identified with local stakeholders involved. First a system analysis was done and problems as well as solutions were jointly identified. It was found that locally a water sharing mechanism is considered a preferred solution. The mechanism was agreed at district level with all stakeholders involved and pilot tested during the summer/autumn rice season of 2015, in two streams (sub-catchments) sharing the water at commune and district level, including alternate distribution of water between drinking water and agriculture use.

Findings: In both Tho and Mo stream a water control and management board was established, based on a



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decision at district level, and after consultation with all parties involved. For the rice growing season during summer/autumn 2015 the water sharing mechanism was pilot tested. It was found in Tho stream, where one commune is involved, that farmers experience water shortage especially at the end of the rice season (August) and that at that time the water use for agriculture competes with drinking water use. The water sharing agreement provided a solution by alternating the water use during the critical period, to the satisfaction of the farmers and the drinking water company.

It was found in Mo stream, where farmers of two communes are involved, that the water diversion for the hydro-power plant and drinking water purposes competes with agricultural water use. Based on the water sharing agreement, the natural flow was maintained, and there was consensus on this solution.

Significance for practical solutions: The water sharing mechanism developed may provide an example for other places looking for practical solutions to address fresh water shortage. In the case in Dai Loc district, it proved to be an important contribution to ensure the use of fresh water for both rice production and drinking water at both commune and district level.

ABSSUB-1096

SC 3.2 Critical periods for adaptation in Asia; irrigation demand by crop linked to water supply by source

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Research question: Especially in South Asia, a shift in time in the supply of water is expected as climate warms and contributions of glacier and snowmelt to runoff from the Himalayan headwaters change. How this shift will affect food production in these highly populated regions is still unknown, as a detailed understanding of the seasonal pattern in water demand is surprisingly absent. This lack of insight in the critical periods for crop production hampers a proper assessment of water stress and ways to cope and adapt.

Methodology: We have estimated the crop specific seasonal pattern of irrigation water demand resulting from the typical practice of multiple-cropping in South Asia and compared it with water availability and supply from different water sources (surface water from snow and glacier melt, monsoon precipitation, reservoirs, sustainable groundwater, deep aquifers).

We introduced a seasonal crop rotation with monsoon-dependent planting dates in a dynamic global hydrological-vegetation model (LPJmI) and calibrated crop yields to the latest state-level statistics of India, Pakistan, Bangladesh and Nepal. Further, we coupled LPJmI to a mountain hydrology model (SPHY) to distinguish the contribution of snow and glacier melt, rainfall, reservoirs and groundwater to irrigation supply. This spatially and temporally explicit analysis directly relates the crops specific irrigation water demand with its sources of supply.

Findings: Crop irrigation water demand differs sharply between seasons and regions; in Pakistan, winter (Rabi) and summer (Kharif) irrigation demands are almost equal, whereas in Bangladesh the Rabi demand is



approximately 100 times higher. Moreover, the relative importance of irrigation supply vs. rain decreases sharply from west to east. Snow and glacier melt mainly contribute to irrigation supply in the upper Indus basin in Pakistan, whereas pressure on groundwater is highest in the hot and dry summer months of April and May, and can to a large extent be attributed to the growth of sugarcane and other annual crops. Critical periods for adaptation are defined.

Significance for practical solutions: Understanding of the size of irrigation water demand during critical periods for water availability, the crops that are responsible for this water demand, and their relative importance for food production is essential to guide design of suitable climate adaptation measures. When combined with information on the (un)availability of surface water from different as well as shallow and deep groundwater, it increases insight in the causes of water shortages and groundwater depletion. Increased temporal detail is needed for properly evaluating the impact of expected shifts in supply of water as a result of a rapidly changing climate, especially in the Himalayan headwaters of some of the main rivers in South Asia. The improved model can support the selection of promising options to decrease irrigation water demand during those critical periods.

ABSSUB-1203

SC 3.2 BeWater: science and society creating river basin adaptation plans to face climate change

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Research question: Climate Change impacts, challenges and adaptation in water management at river basin level in the Mediterranean region. Implementation of multi-stakeholder dialogue methodologies and knowledge exchange.

Methodology: BeWater project promotes dialogue and collaboration between science and society for sustainable resilient water management and adaptation to the impacts of global change in the Mediterranean. With the aim to integrating physical, ecological, social and management aspects into the design of specific river basin adaptation plans, an innovative methodology is being developed and applied in four Case Study River Basins, CSRBs (Pedieos, Cyprus; Rmel, Tunisia; Tordera, Spain and Vipava, Slovenia) which are representative of various Mediterranean conditions with regard to climate, topography, environment, socio-economic and political conditions, land use and water demands. The project runs an iterative process in each of the CSRBs, in which the work prepared by scientists was evaluated, enriched and validated through the participation of society in repeated exchanges. The outcome of society's participation was integrated into the work prepared by the scientists. Scientific data from CSRBs integrated into the project available data for current river basin status and future projections related to: water quality and availability, basin hydrology, climate data, extreme event monitoring data, GIS data, soils and geological information, as well as relevant infrastructures, population, land and water use data. By actively engaging with local communities, a comprehensive diagnosis identifying the most relevant vulnerabilities was developed in each basin and relevant options to tackle these challenges were set. Information gathered was structured applying Fuzzy Cognitive Mapping methodology, creating a model representing the basin's current state integrating quantitative and qualitative data. Furthermore, concrete water management options were developed and analysed involving stakeholders in the evaluation and



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prioritization of measures through the application of a Multi-Criteria Analysis (MCA).

Findings: The process allowed envisioning how scientific evidence relates to societal perspectives.

Intermediate results already clearly show that currently climate services are not coherently integrated into the rationale of river basin management policies. An iterative process of interaction between scientists and multisectoral stakeholders allowed carrying out processes of mutual learning, participation and bottom-up policy design, ensuring stakeholders to play an active role in determining appropriate adaptation strategies. Final results of the project aim to obtain locally-relevant adaptation plans which may be scaled up to develop guidelines of national and international relevance.

Significance for practical solutions: Practical experiences, in 4 diverse pilot cases, of making society an active participant in water adaptation to climate change for a more sustainable, resilient and adaptive river basin management.

ABSSUB-354

SC 3.3 Climate adaptation for food security and farming livelihood in Small Island Developing States (SIDS)

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Research question: Climate change is predicted to have an effect on global precipitation patterns. This would in turn affect freshwater resources, which are largely dependent on rainfall. Small Islands Developing States (SIDS) due to their size and geographies will be particularly vulnerable to changes in available water resources. Caribbean SIDS are increasingly urbanised and this is already having an impact on consumption patterns, including the use of water. At the same time food security is becoming an increasing concern and has led to attention being focused on increasing agricultural production for domestic consumption in Caribbean SIDS with concomitant impacts on agricultural livelihoods. These dual drivers of water demand when coupled with the likely effects of climate change on water resources require serious consideration.

Methodology: However, there have been relatively few initiatives in SIDS that have attempted to investigate, conjointly, the consequences of climate change on water availability and livelihoods particularly in the agricultural sector. This research has developed a nonlinear optimization framework that maximizes the economic rural livelihood derived from irrigated agricultural production, under climate change scenarios in Barbados. It does so by employing downscaled data on precipitation from IPCC emission scenarios that integrated with farm budget data and aquifer characteristics. Adaptive measures, such as subsidized drip irrigation have been investigated.

Findings: Findings indicate that there would be significant impacts on water availability, food security, and farming livelihoods under different IPCC climate scenarios. Some of the IPCC climate scenarios are shown to be associated with significantly negative impacts on water availability and food security.

Significance for practical solutions: The findings provide policymakers and stakeholders with a comprehensive evaluation tool that can contribute to the assessment of economically efficient and sustainable policy design and implementation under potential climate change impacts.



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SC 3.3 Freshwater supply: the subsurface to the rescue

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Research question: How can dedicated hydrogeological solutions in the subsurface contribute to future climate adaptation?

Methodology: The efficiency of subsurface water solutions to enable a reliable freshwater supply (quantity and quality) is evaluated. First, the set-up and results of current Dutch reference sites where subsurface water solutions are tested in the field since 2012 are presented. This comprises aquifer storage and recovery (ASR), the Freshkeeper (brackish water interception below a fresh water well field), and the Freshmaker (enlargement of freshwater lenses using horizontal directional drilled wells). In a next step, the applicability of the subsurface water solutions is explored at four replication sites. Finally, the (market) opportunities for replication of subsurface water solutions are presented.

Findings: ASR was applied at two field sites in the Province of South-Holland. Here, it was demonstrated that, despite relatively high salinities in the target aquifers, rainwater could largely be recovered upon storage using multiple partially penetrating wells. The Freshkeeper was applied at a salinized well field in Noardburgum (province of Friesland) and led to freshening and lasting protection of the fresh water abstraction wells. Finally the Freshmaker was successfully applied in the Province of Zeeland, where fresh surface water was stored and successfully recovered for irrigation in an orchard. The ASR technique was readily replicable for storage of recycled effluent from a sugar factory in Dinteloord. At the Falster (Denmark) en Schinias (Greece), replication seems feasible, but new research question regarding the limestone target aquifers arose. In the Gulf of Mexico (Florida, Mexico), feasibility studies for the Freshkeeper resulted in positive prospects.

Significance for practical solutions: Traditionally, aboveground solutions like reservoir storage and treatment/desalination are sought to solve fresh water supply issues. However, the subsurface may provide far more interesting solutions due to limited use of above ground space, protection from evaporation/contamination, and the immense capacity. Subsurface water solutions can successfully bridge periods of water availability and demand, counteract salinization, or help preventing pluvial floodings. For those reasons, it is expected that subsurface water solutions will play a significant role in future climate adaptation.

ABSSUB-1403

SC 3.3 Flood water conservation underground - Case Study: Indus Basin to improve water quality & quantity

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Research question: Pakistan is currently close to using all its water resources, but yet it is projected that over 30 percent more water will be needed for the next twenty years to meet increased population, agricultural, domestic, and industrial demands. Pakistan has about 145 million acre feet (maf) total annual average of



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surface water production. But average annual escapage drained/wasted unused to the sea is about 35 to 38 MAF, though only about 10 MAF is required to be drained for the sustainable delta development. That means, the largest additional required water potential can come from the average flow to the sea which is about 25 MAF (about 17 % of the total 145 MAF) annually, mostly in form of flood water that can be stored underground as one of the alternative reservoir in the wet season, because there is lack of consensus among the provinces in Pakistan for the implementation of Kalabagh Dam project. In Pakistan, three years of repeated floods in 2010, 2011 and 2012 inflicted serious damage on the national economy, halving its potential economic growth, additionally Pakistan lost a total of 3,072 lives and US\$16 billion to the 2010-2012 floods. The groundwater annual abstraction in Pakistan has increased from about 4 MAF in 1959 to more than 50 MAF.

Methodology: The innovative idea is to divert surplus SAFER FLOOD WATER of about 25 MAF annually for example from Indus to Jhelum through gravity flow groundwater recharging canals to avoid any flood disaster in the downstream, to utilize this surplus diverted flood water to recharge the over mined & contaminated aquifers, utilizing partially already existing infrastructure like dried river beds available of the eastern rivers, Ravi, Sutlej & Bias after the Indus Water Treaty (IWT), to compensate aquifer's water quality & quantity and also for groundwater recharge purpose for the coming droughts and also to save it from evaporation losses.

Findings: The idea, if implemented successfully, will be flood & drought proofing for Pakistan to secure the water quality & quantity, food & electricity production for the growing population. It will also save water from evaporation losses, thus also reduction of poverty & to enhance employment in remote areas.

Significance for practical solutions: Pakistan had already completed successfully a similar gigantic project of Indus Basin Replacement Works (IBRW), it was rather the biggest irrigation project (cost of Pak Rs. 124 billion) of the world at that time (after 1960), which was completed within only ten (10) years, and by which about 13.75 MAF/annum (about 17 BCM/year) of water was transferred from western to eastern rivers. If this Idea is Implemented, about 25 MAF can be added annually to the total Surface & Ground Water system of the Indus Basin.

ABSSUB-1010

SC 3.3 Water poverty in small islands: natural laboratories for global water management

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Research question: Availability and access to fresh water are key aspects to poverty reduction and food security. Today more than one billion people lack access to drinking water and nearly half of them are concentrated in the Asia-Pacific region. Although several studies on water scarcity in small islands have been



conducted in recent years, hardly any attention has been paid on the Indonesian Archipelago. Water scarcity is now increasingly understood as a multidimensional concept involving physical, socio-political, and economic issues and the integration of these dimensions has led to the concept of water poverty.

Methodology: We present here a study concerning the status of water resources in small coral islands of the tropical Pacific. Our work is based on socio-economic and ecological observations conducted in six representative islands of the Spermonde Archipelago, South Sulawesi (Indonesia). We analyse our data using the Water Poverty Index (WPI) as a global indicator of the physical, economic and social dimensions of the water resources in a local-scale context.

Findings: The evaluation through the WPI clearly shows that (1) water poverty is a pressing problem in the Spermonde Archipelago, (2) although the islands are geographically located in the same Archipelago, the intensity with which they are influenced by water poverty is not the same in all cases, (3) key issues include water quantity, water quality, and costs, and (4) the unequal status of water resources on the islands influences the use and consumption of water by the population. Our finding illustrates the diversity and specificity of the factors involved in the water scarcity problems and highlights the need to develop unique adaptation strategies in the different islands.

Significance for practical solutions: We present here an innovative way to assess water poverty in small islands, often perceived as semi-enclosed natural laboratories in which water-related problems occur in a condensed way, by using the WPI as a highly replicable tool at a larger scale to provide global solutions for water management.

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SC 3.3 Quantifying present and future water availability in selected Caribbean catchments

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Research question: The Small Island Developing States (SIDS) of the Caribbean region are expected to be one of the earliest areas to be severely impacted by climate change due to the sensitive nature of their water-dependent economies. Integrated Water Resources Management (IWRM) has therefore become a necessary part of Caribbean government mandates in the hope of mitigating the predicted impact on the water supply. The question of the quantifying present available water and the effect of projected precipitation changes; for the near term (2035-2045) and long term (2065-2075); on its volume and allocation is what this research seeks to address.

Methodology: Although having contrasting hydrogeological characteristics, the Speightstown catchment, Barbados and Carriacou, Grenada are both water scarce. Downscaled ECHAM climate data for the SRES A2 scenario; the worst case for the region; projects rainfall decreases of 23% to 43 % and 67% to 68% in the near to long term for both areas respectively. A conceptual model was first developed based on primary and secondary data collected. Within the Water Evaluation and Planning Tool (WEAP), a 'current accounts' year, from which projections would be simulated, was chosen based on data availability. Derived from this was a 'business as usual' baseline from which future scenarios were inherited and percentage changes in rainfall



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applied to simulate impact. The model was first set to analyse the available headroom for the baseline (2000-2013) with rainfall being the only variable changed for future projections.

Findings: The preliminary results estimate; based on the current accounts year 2000; that the annual total groundwater storage for the Speightstown catchment is 329.74 MG, whilst the demand is 307.5 MG, giving an estimated annual headroom of 22.34 MG. For the island of Carriacou, where rainwater harvesting is the primary water supply, the annual storage value for the year 2002 is 115 MG, whilst demand accounts for an 84.4 MG, giving an estimated annual available headroom of 30.6 MG. The projected scenarios have shown unmet demand volume in the Speightstown catchment increasing to 50 MG in the near term and 128 MG in the long term. In Carriacou, the average annual unmet water demand increases to 15 MG in the near term and to 17 MG in the long term. It is therefore likely, from the forecasted precipitation decreases simulated, that these areas are at high risk for severe, nearing perpetual droughts.

Significance for practical solutions: The research highlights the usefulness of WEAP as both a predictive and planning tool for water managers. Notwithstanding the dearth of research in quantifying water resources in the Caribbean, this novel work creates a modelling framework that can be simplified and used to by policy-makers to guide their decision-making. This work also allows for future water availability estimates to be made as a strategic and informative step toward climate change adaptation.

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4. PUBLIC HEALTH





ABSSUB-1300

SC 4.1 Limits to health adaptation in a changing climate

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Research question: Because the health risks of climate variability and change are not new, it has been assumed that health systems have the capacity, experience, and tools to effectively adapt to changing burdens of climate-sensitive health outcomes with additional climate change. However, as illustrated in the Ebola crisis, health systems in many low-income countries have insufficient capacity to manage current health burdens. These countries also are those most vulnerable to climate change, including changes in food and water safety and security, increases in extreme weather and climate events, and increases in the geographic range, incidence, and seasonality of a variety of infectious diseases. The purpose of the study was to conduct a systematic evaluation of the effectiveness of health adaptation interventions to identify lessons learned and best practices.

Methodology: To facilitate assessing and overcoming barriers to implementation and to scaling up, a desk review of evaluation reports and other materials was conducted from the first five years of implementation (2008–2013) of multinational health adaptation projects in Albania, Barbados, Bhutan, China, Fiji, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Philippines, Russian Federation, Tajikistan, and Uzbekistan. Qualitative data were collected through a focus group consultation and 19 key informant interviews.

Findings: National health plans, policies and budget processes need to explicitly incorporate the risks of current and projected climate variability and change. Lessons learned include that increasing resilience to the health risks of climate variability and change is likely to be achieved through longer-term, multifaceted and collaborative approaches, with supporting activities (and funding) for capacity building, communication, and institutionalized monitoring and evaluation. Projects should be encouraged to focus not just on shorter-term outputs to address climate variability, but also on establishing processes to address longer-term climate change challenges. Opportunities for capacity development in the health risks of climate change should be created, identified and reinforced for the full range of actors.

Irrespective of resource constraints, Ministries of Health and other institutions working on climate- and health-related issues in low- and middle-income countries need to continue to prepare themselves to maintain or improve health burdens in the context of a changing climate and current socioeconomic development patterns.

Significance for practical solutions: The best practices and lessons learned can be used when designing and implementing new health adaptation projects to increase their effectiveness and relevance.



ABSSUB-613

SC 4.1 Imagining the unmanageable: Limits to health system adaptation in high-income countries

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Research question: High-income countries are not subject to the same degree of health impacts from climate change as low- and middle-income countries. They don't have the same underlying vulnerabilities such as rapid population growth, crowding, or a heavy burden of communicable diseases. They also tend to be less environmentally vulnerable. Their health systems generally function well, emergency warning and response systems work, and government revenue can be re-routed to assist with recovery following disaster. They are, in effect, somewhat buffered against the adverse health impacts of climate change. Even with global attention now focussed on climate change, health impacts remain a lower order priority in high-income countries and are still not given consideration in health service planning. High-income countries may cope reasonably well with gradual changes to health outcomes, but a number of recent incidents demonstrate that they are ill-prepared for extreme and unprecedented events. Some examples are extended drought and wildfires (California, USA), extreme heatwaves (Melbourne, Australia), and intensified seasonal storms (Mediterranean). Despite having considerable resources with which to plan for and respond to such events compared with less wealthy countries, the greater costs associated with increased and more intense events could heavily affect national finances, especially in the face of other global economic pressures, including recurrent economic recessions. What are the limits to health system adaptation in high-income countries, and what are the broader health and economic impacts?

Methodology: By building on recent case studies of unprecedented climate events and the associated health outcomes, we explore the likely impacts of future extreme events on health systems and public finances in high-income countries, including the ability of health systems to respond and adapt to climate change. By combining past experiences with hypothetical examples of future events, we look at how climate change could affect functioning, well-resourced health services, and the ways in which planning may be improved to meet climate challenges to human health.

Findings: High-income countries are already experiencing significant climate change related events that affect the health of their populations. Health systems are being challenged, especially when subject to additional economic pressures.

Significance for practical solutions: High-income countries need to consider climate change in their health system planning, as well as accounting for the costs when drafting national budgets. Further, demonstrating that high-income countries are not immune to the health impacts of climate change may encourage greater reductions in emissions from some bigger polluting countries, taking advantage of co-benefits, while these countries could also lead development of more sustainable, climate-ready health systems.



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SC 4.1 The importance of evidence-based public health research to address the risks to health from climate change

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Research question: What is the current state of public health responses to climate change in the South East Asia Region (SEARO region of the World Health Organization) and what are potential next steps to strengthen country and regional responses? The research had two aims – i) to review the current evidence base on the health impacts of climate change in each country and the region, as well as country-level responses to these, and ii) to develop clear, defined and achievable activities to respond to these impacts.

Methodology: The South East Asian Regional Office (SEARO) of the World Health Organization (WHO) recently (2014-2015) conducted a review of its member countries' (Bhutan, Nepal, Sri Lanka, Indonesia, India, Thailand, Maldives, Timor-Leste, Myanmar, Bangladesh) activities to respond to risks to public health from climate change. The project comprised a combination of document reviews, stakeholder interviews, and electronic surveys.. The resultant presentation of well-developed and justified activities for funding was considered particularly vital for the project given the increasing funding being pledged allocated to both adaptation and mitigation activities.

Findings: The shift to evidence-based public health practice with regard to developing programmatic and policy responses to the health risks posed by climate change is an important development, and this project demonstrates an approach to achieve this. The project has the potential to be replicated elsewhere, and for other sectors.

Significance for practical solutions: The practice of evidence-based public health has clear relevance for designing responses (both programmatic and policy) to prepare for the health risks posed by climate change. It is becoming increasingly important to ensure that the public health activities that are designed and implemented are based on a proper and well-grounded evidence-base. The notion of 'evidence base' includes both qualitative and quantitative methods, as well as the genuine inclusion of relevant stakeholders, including state and non-state actors.

ABSSUB-1564

SC 4.1 Child-focused Health System Adaptation to Climate Change

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Research question: Globally, the greatest proportion (over 80%) of all-cause disease burden falls on children. This proportion is mirrored in projected climate change burden underscoring an enormous equity issue and the need for climate adaptation approaches that incorporate child-centric planning. In particular, such climate adaptation strategies need to include these child-centric plans in health system capacity and



resiliency. Furthermore, as per the Lancet Commission's June 2015 Report, "Tackling climate change could be the greatest global health opportunity of the 21st century." And the stakes are high as failure to act risks undoing half a century of progress in global health. Thus, the evidence of the interplay between mitigation and adaptation actions as relates to health adaptation is clear. Depending on the organizational structure and available resources in each country, public, private, and non-governmental stakeholders play key roles in health system adaptation with potential services ranging from syndromic surveillance to health care delivery and key infrastructure support. This work also requires interdisciplinary collaborations across stakeholder lines. Are child-centric interventions possible and what lessons can be learned from projects that have already attempted such an approach?

Methodology: Using a case study approach drawing from the published literature and the presenter's own work, we explore several cases of child-centric interventions in low and middle income country health system projects.

Findings: Existing child-centric health system adaptation projects highlight the possibility of a life-course framework and expansion on to date fairly limited interventions.

Significance for practical solutions: Consideration of the impacts of climate change on vulnerable populations particularly in regards to health system planning is paramount to avoid exacerbation of existing inequities in health. Further, showcasing of successful pilot scale projects that use a child-centric approach may encourage additional larger scale projects and ultimately a more resilient global health system.

ABSSUB-1043

SC 4.1 Is adaptation to warming world effective? - Difficulty in implementing heat-health warning system

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Research question: It is obvious that setting a room temperature cool enough can prevent heat-related mortality/morbidity completely. In Japan, weather forecast programs by all the TV channels have spent a lot of time to explain how we can prevent heat-stroke during summer; still, the number of heat-stroke patients brought to emergency rooms increases every time the temperature becomes high. To reduce heat-related mortality/morbidity, we conducted intervention trials in Japan. Here, based on these trials, we show why the TV programs have not been successful.

Methodology: We conducted two trials to evaluate how effective our intervention is in order to increase the number of participants who follow our instruction (i.e., who change their behavior).

The sites we investigated were Goto, Nagasaki Prefecture and Misato, Saitama Prefecture, both of which have subtropical climate.

In Goto, we delivered bottles of water and simple thermometer to each participant with some instructions to follow (drink more and use air conditioner based on the room temperature) to avoid heat-related illness. In Misato, we asked a NGO group to visit the participants and to give them tumblers and thermometers that can issue warning based on the temperature and humidity. In both trials, we obtained the participants' knowledge on how they can avoid heat-related illness and whether they have air conditioners or other cooling devices. We also asked about their behavior before and after the trial.

Findings: The modification of participants' behaviors was observed but limited, partly because majority of the



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participants already had knowledge that they should drink more and turn the air conditioners on during very hot period.it was not all of them.

Preliminary economical evaluation of the Goto trial revealed that the cost to save lives was prohibitively high, mainly due to the cost of distributing water bottles.

Significance for practical solutions: Our intervention trials reveal that, although majority of people are aware of specific measures to reduce heat-related illnesses, substantial proportion of them did not behave properly even after our intervention. We thought that this portion of people is the cause of heat-related morbidity/mortality increase, and that it is hard to change their behaviors. Considering that the proportion of elderly will constantly increase over time and there exists a substantial amount of those with cognitive impairment among them, we can easily expect the increase of those who cannot behave properly to prevent heat-stroke, or heat-related diseases.

Based on the above studies, we have the limit to the adaptation to warming climate in terms of heat-related illnesses.

Along with mitigation effort, we need more focused and intensive adaptation measures to substantially reduce the impact of heat-related morbidity/mortality; it would be, however, economically prohibitive.

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SC 4.2 Evaluation of information systems relevant to climate change and health

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Research question: For more than a decade climate change-related forecasting and early warning systems have been established in Germany. Their aim is to inform the general population and vulnerable groups (e.g. elderly, one-person household) on the current and predicted situation to prevent health damages by better individual adaptation. After the extreme summer 2003 these systems were expanded by the heat health warning system. From environmental health viewpoint it is of utmost interest to know if, when and how the information reaches the people. Important is also, whether the information is sufficient and understandable. For effective adaptation people need adequate information. Because information on the reception of climate change-related information systems is missing, the Federal Environment Ministry and the Federal Environment Agency (UBA) launched a two years research investigation (2012-2014) as contribution to the 'German Strategy for Adaptation on Climate Change/DAS' to evaluate selected information systems in Germany: (1) heat health warning, (2) solar UV radiation index, (3) tropospheric ozone and (4) pollen forecasting. The project also aims at optimizing current communication strategies and concepts.

Methodology: The main project module had been carried out as a German-wide representative telephone survey of the general population (20 minute interviews of 4,000 residents, aged 14 years and older; about 250 per Federal State) during summer 2013. The survey questionnaire was pretested to assure understanding. A second project module investigated the knowledge and perception of local physicians/medical practitioners on climate-change-related information and warning systems and their access to it.

Findings: Warnings and forecasts reach the population primarily by way of non-institutionalised communication. Public awareness is strongly dependent on the information system involved. 86.8 % have heard or read about pollen forecasts, but only 29.5 % about the UV index. Heat health warnings (71.0 %) and ozone forecasts/warnings (54.2%) lie in-between. Those questioned became aware of warnings and forecasts most often through television, radio, newspapers or magazines, or the Internet. The observation of the media showed that the media inform primarily about heat, but neither ubiquitously nor reliably. The utilisation of institutionalised information is extremely inconsistent. Only heat health warnings are received by almost all federal states but the forwarding of the information is not uniform.

Significance for practical solutions: To protect public health and to strengthen individual health resilience of the population in the future it seems to be essential to consider the study recommendations and to adapt an approved communication concept appropriate to cope with (extreme) events of climate changes. In addition, warnings and forecasts should be forwarded to public agencies and health facilities to establish proper institutionalised communication channels.



ABSSUB-985

SC 4.2 Experiences from a communication campaign to foster adaptation to increasing heat extremes

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Research question: What are psychological drivers of self-protective behaviour among older people regarding heat extremes and by which measures can self-protective behaviour be increased? These were the two main research questions of a study on the development of effective communication formats to increase heat preparedness in Germany.

Methodology: The study first conducted a representative telephone survey with 501 people aged 65 and over. Different from most current practice in the development of information on climate adaptation we also tried to understand the drivers of and barriers to their self-protective behaviour. We developed the survey questions from current psychological knowledge on explanatory factors for self-protective behaviour. Primarily, three influential theories on self-protective behaviour guided the questions included in the survey: Protection Motivation Theory, Health Belief Model and Norm-activation Theory.

Based on the results of the telephone survey and good practice examples of heat plans we conducted and evaluated a communication campaign in summer 2015 in a small heat sensitive district of Berlin (Germany). The campaign focused on significant determinants of self-protective behaviour, for example by increasing outcome-efficacy beliefs among the elderly by communication formats such as posters, reminders and a brochure mailed to households with older people. The campaign also tried to stimulate a strong involvement of community members as trusted messengers of information on self-protective behaviour and as "heat buddies", who help older people during heat waves (e.g. with doing their groceries or providing cooling places).

Findings: Multiple regression analyses detected the following statistically significant determinants of self-protective behaviour in our sample of 501 survey participants: (i) a combined measure of self-efficacy and outcome-efficacy beliefs regarding self-protective behaviour, (ii) subjective norm / perceived responsibility for self-protective behaviour, (iii) a combined measure of heat risk experience, risk perceptions and risk related worry, and (iv) gender. Women showed more self-protective behaviour than men. Whereas the communication formats of the campaign were very well received the community involvement was below expectations due to a variety of reasons. Community organisations and businesses in the district were contacted too late (in spring before summer 2015), occupied with other interests or duties (particularly with caring for refugees) or not willing or able to provide cooling places.

Significance for practical solutions: Knowledge on psychological drivers and barriers of self-protective behaviour helps in designing effective communication formats that have the potential to increase such behaviour. Nevertheless, these communication formats can only develop their full potential if combined with community involvement strategies that are time-consuming and often difficult to establish regarding adaptation to climate change.



ABSSUB-352

SC 4.2 Changes in the heat-health relationship across the usa, 1975-2010: adaptation and its limits

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Research question: There is ample evidence to suggest that excessive heat is deadly. Yet mortality rates vary, and the temporal changes in mortality over the years has not been fully studied. Future changes in demographics will substantially increase the number of those most vulnerable to the heat, the elderly. Climate changes are expected to increase both the number of hot days and the number of extreme heat events. However, several studies have suggested that heat vulnerability has decreased over time. This research aims to assess changes in vulnerability to different types of heat events over time, to help better understand the relative levels of adaptation over recent decades.

Methodology: Using 36 years of mortality data for the US, a distributed lag non-linear model was used to examine trends in heat-related mortality across the 61 largest metropolitan areas for the period 1975-2010. Various definitions of heat, age subsets, lag structures, length of heat wave, and seasonality were all evaluated. Relative risks were compared across the metropolitan areas to assess temporal changes.

Findings: Across all definitions, the mean relative risks of mortality on hot days have decreased over time. Far fewer metropolitan areas were associated with statistically significant increases in mortality during hot weather in more recent years; only around one sixth of all metro areas were still significant during the 2000s. Cities in the cooler climate regions are generally more vulnerable, as are older populations. Within this broad decline, however, are changes in vulnerability that can also be associated with the frequency of heat events. In intermittently affected areas, such as Seattle, heat vulnerability has not decreased as substantially as in other places.

Significance for practical solutions: With increased awareness and health care, heat-related mortality is overall less substantial than decades ago across the US. This noted, there still are increases in mortality in heat events in many cities, particularly in places intermittently affected by heat events; the elderly are particularly more vulnerable than the overall population. Understanding the spatio-temporal differences in heat vulnerability, within the context of changing demographics and climate, is important for understanding societal vulnerability and the limitations to adaptation.



ABSSUB-815

SC 4.2 Assessing costs and benefits of heat warning systems at European level: a methodological framework

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Research question: In a changing climate heatwaves will pose an increased threat to human health especially in urban areas and among vulnerable groups. To mitigate these impacts, warning systems (HHWWS) are typically set up to provide early alerts and emergency measures. Future local governments in urban areas that currently are not faced with severe heat events will probably have to consider contingency plans. Against this background, this paper aims to estimate the potential costs and benefits associated with the implementation of HHWWSs at European level by the end of the century, under scenario RCP8.5 and SSP5.

Methodology: Our study considers the national scale. We assume that an alert situation occurs when the country average maximum daily temperature exceeds the 98th percentile. Climatic data are from CMIP5 with daily maximum temperature for 2006-2099 under scenario RCP8.5.

Mortality is assessed as premature deaths related to people in normal health who would die because of the heatwave, and displaced years of life lost for people already in poor health who would die in the short term regardless of the heatwave. To estimate the attributable risk at country level, a regression function is built to transfer data from city to country level. The benefits of the HHWWS are the avoided premature deaths (valued in terms of value of statistical life) and the displaced years of life lost (valued with the value of one year life). The costs are the sum of annual fixed and variable costs in terms of cost per day of alert, when the maximum daily temperature is expected to be above the stated threshold.

Findings: Expected impacts of climate change, benefits and costs of adaptation are calculated annually for the period 2015-2099 at country level. The cost-benefit ratio is estimated for different levels of system effectiveness and unit cost/benefit. Results show always a positive ratio with high expected health benefits if compared with the costs, indicating that the HHWWS is a low regret measure. The ratio increases with a higher effectiveness of the system, while it decreases with the cost of the system. Several factors contribute to the evolution of the threshold temperature, such as physical acclimatisation, implementation of appropriate adaptation measures and ageing population. While the first two would increase the threshold over time, the third factor acts by lowering threshold.

Significance for practical solutions: Total implementation costs of the system depend on the number of days in which the HHWWS is activated, which is the number of days in which the maximum temperature exceeds the critical stated threshold. The HHWWS usefulness depends on the correct specification of the threshold temperature. If the correct threshold is not taken into account when running the HHWWS, the society would incur in a loss of health benefits which would be otherwise observed, or in additional costs of implementation if the system is launched for more days than requested without expected additional mortality.



ABSSUB-346

SC 4.3 Heat waves, human health and adaptation: an empirical study in West Bengal, India

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Research question: Every year India experiences severe heat waves in summer, but in the year 2015, deaths were abnormally high stood at more than 2500. More than 20,000 people have died of heat-related causes in India since 1990. Many of India's 1.2 billion people live in areas vulnerable to floods, cyclones and droughts. The paper attempts to address the occurrence of heat waves in relation to human mortality pattern in India and the distribution of disease vectors like malaria, dengue and the incidence of diarrhoea diseases in response to climate change.

Methodology: The paper utilizes time series data on temperature and precipitation, number of heat waves and deaths of human lives, number of malaria cases from the various reports of Indian Metrological Department for period 1978 - 2008. Regression analysis was done to estimate the effects of temperature on heat wave human mortality and to estimate the effects of precipitation on malaria cases. The paper is also an empirical study based on data collected through field survey. Two villages from Coastal Sunderbans in West Bengal with 202 households and other two villages from drought prone district of Bankura in West Bengal with 120 households in 2011 are taken into the analysis.

Findings: The results of the paper revealed that there is a positive and significant relation between the temperature rise and heat wave human mortality while there is a positive and significant relation between precipitation and malaria death in India. Diarrhoea, malaria vision problems and skin diseases are the common diseases prevailed in both the study area. The paper also revealed the household's adaptation strategies like boiling of water for drinking purposes, use of net from mosquito, use of sanitation, migration, use of umbrella.

Significance for practical solutions: This paper is highly significant for enhancing public health policy to build up capacity building of the communities to cope with climate change.

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SC 4.3 Understanding the heat waves and its effects in Nagpur, India

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Research question: As heat-related human impacts due to climate change is a growing concern in the developing countries. In 2015, India witnessed heat waves in multiple regions across the country with different intensity devastating more than 2,300 lives. Vidharba region in the central part of India is one of the driest and hot climates badly affected due to heat waves. The study focus on the largest city in the Vidharba region called Nagpur and the primary motto of this study is to assess the heat-related human impacts in those regions in the past 15 years and to draw mitigation strategies in near future from the deadly heat waves. The study mainly focuses on the understanding of the relationship between Temperature and mortality in a dry climate environment and suggest suitable adaptation plan in public health perspectives.



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SC 4.3 ADAPTING TO HEAT IN SOUTH ASIA

Methodology: We assess the all-cause mortality with the temperature obtained from Indian Meteorology Department for the period (2000–2015). From the descriptive analysis, we got mean mortality for the years adjusted to the population. We compared the mean mortalities for the month of May and June for each year with every other year within the study time frame. In order to get the temperature-mortality relationship precisely; we used spline method to fit the curve. We also used the Classification and Regression Trees (CART) method to see the relationship between the Mortality and Minimum and Maximum Temperatures.

Findings: From the analysis, we got a strong evidence of three deadly heat waves devastated the city in the past in the years 2003, 2010 and 2014. The Maximum Temperature in the year 2003 had risen to 47.7°C and there were about 867 excess all-cause mortality were registered compared to the reference period. Also, similar trend in the years 2010 and 2014 were observed with excess all-cause mortalities of 1,214 and 764 respectively.

Significance for practical solutions: From the findings, we strongly suggest that the city needs an adaptation plan for the heat-related illnesses. The city has to devise the mitigation plan that creates the awareness among the public regarding heat waves and its impact on the health. We also suggest that city want to create an early warning system that will alert the public about the heat waves, preparedness plans and information sharing between government agencies and key stakeholders in public health to address this issue.

ABSSUB-801

SC 4.3 Development and implementation of heat-health action plan in Ahmedabad - a success story

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Research question: Heat waves in Ahmedabad – a top 10 fastest-growing city in India – are becoming increasingly deadly, exacerbated by climate change. The Public Health Foundation of India, Indian Institute of Public Health, Gandhinagar, and Natural Resources Defense Council are working with city officials and the health care sector to protect people from Ahmedabad's rising temperatures. To address this concern in Ahmedabad (Gujarat, India), a coalition has been formed to develop an evidence-based heat preparedness plan and become the first city in South Asia to comprehensively address the threat of extreme heat caused by climate change.

Methodology: Using qualitative vulnerability assessments, community surveys, and focus-group-based workshops with the municipal government and health care workers, we have identified the most heat-vulnerable populations. Ongoing qualitative and quantitative efforts are focused on developing targeted climate change adaptation strategies to enhance these groups' resilience in the face of extreme heat. Initial results indicate that the following groups are most vulnerable – slum communities, the elderly, new-borns, and outdoor workers. Quantitative assessment indicates an excess in total mortality during heat waves, particularly during the 2010 heat wave in Ahmedabad.

Findings: The findings and recommendations were encapsulated in policy briefs for key government agencies, health care professionals, outdoor workers, and slum communities, and synthesized in the heat preparedness



plan. A 7-day probabilistic weather forecast was also developed and is used to trigger the plan in advance of dangerous heat waves. The pilot plan was implemented in 2013, and public outreach was done through training workshops, hoardings/billboards, pamphlets, and print advertisements. Evaluation activities and continuous improvement efforts are ongoing, along with plans to explore the programme's scalability to other Indian cities, as Ahmedabad is the first South Asian city to address heat-health threats comprehensively.

Significance for practical solutions: Ahmedabad's Heat Action Plan is a strong model for how cities can manage risks from rising temperatures through public outreach, capacity building and interagency coordination.

ABSSUB-902

SC 4.3 Heat stress and human health: vulnerability of rural communities in dry semi arid areas of India

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Research question: Which segments of the semi-arid rural population are most impacted by heat stress? What are the factors contributing to vulnerability to heat stress? What strategies are used to prevent and manage heat stress, and the barriers and enablers of the same?

Methodology: This is a two stage, mixed-methods study. Stage 1 (Summer 2015) is a qualitative exploration in three semi-arid villages (Jalna District, Maharashtra). First, the socio-demographics, and perceived climatic trends and impacts were documented using a standardized tool. Following that, focus group discussions were conducted with local farmers (men and women), the landless, and the elderly about heat exposure, perceived health impacts, coping strategies, and trends impacting vulnerability to heat. Key-informant interviews were also conducted with local healthcare providers and governmental employees. The data was analysed thematically. In Stage 2 (summer 2016), a detailed household survey would be taken up based on findings of stage 1.

Findings: Heat was perceived to be a problem, and worsening over time. But it is not a priority issue. Exposure was reported in the contexts of outdoor work and indoor environment (due to inappropriate housing material and design). Local medical practitioners did not think heat was a significant health risk. However, several minor impacts (on well-being and work output) were reported, with a few cases of serious illness and one death. Women working outdoors, the elderly, and very young children of poorer households were found to be more vulnerable. Coping strategies included exposure reduction (managing work timings, protective clothing, taking breaks during work, sitting under trees, changing the mode of transportation), addressing physiological needs (consuming water, adjusted food habits), modifying the environment (using fans and coolers) and managing impacts (accessing healthcare, home remedies). Some trends affecting vulnerability include changes in roofing material (further dependent on governmental subsidies), clothing material, access to water, tree cover, and access to healthcare among others.

Significance for practical solutions: Policy decisions that are increasing the vulnerability to heat were identified and will be shared with decision-makers. Strategies to reduce vulnerability at individual, household and community level (as perceived feasible by participants) were also identified and can inform programmes in affected areas. Further information is expected to come through stage two of this study. The findings would be relevant to large parts of India where summers are similarly hot and dry.



ABSSUB-1177

SC 4.4 Multiple stressors: household vulnerability to schistosomiasis and climate change in rural Gwanda

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Research question: What are the potential implications of climate change and socio-economic factors in determining household vulnerability and resilience to schistosomiasis and climate change related perturbations?

Methodology: Nine focus group discussions were conducted. Livelihoods data was collected in 122 questionnaires administered in Ntalali ward, Gwanda district.

Findings: Schistosomiasis interventions are aimed at vector and parasite control ignoring climate change perturbations on the community. The community hold negative perceptions to the intervention programmes. Communities define 'vulnerable household' as one that solely relies on agriculture and with no one who earns income that is not based on peasantry agriculture. About 96% (n=122) of the respondents received remittances. The average household income is US\$159. About 46% of the respondents get help from relatives in times of perturbations. Natural and physical capital was ranked and it was 2.9/5 and 3/5 respectively. There was a high dependent population ratio of 3:1. Droughts were the major stressor amongst other stressors. Drought to normal rainfall seasons were perceived to coincide with high schistosomiasis incidence. 42% of the respondents witnessed at least a schistosomiasis case in Ntalali. Villages close to the major water bodies were perceived to be at higher risk to schistosomiasis. Due to the politico-economic crisis in the country, rural communities attempt to cope without state support. Communities cope with droughts by engaging in riverside gardening, gold panning, piece jobs, selling livestock, fishing and petty trading. In the long-run adaptation strategies include; investing in both donkeys and cattle, adopting drought resistant crops, irrigations, reverting to traditional rain ceremonies and employment in urban areas and other countries.

Significance for practical solutions: Government interventions and health policy should consider mitigation strategies for vulnerable communities to water borne diseases like schistosomiasis to reduce vulnerability. Local communities in Gwanda are adapting to perturbations by turning away from upland agriculture.

ABSSUB-1512

SC 4.4 Climate change effect on malaria treatment cost among farmers' households in Bole district, Ghana

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Research question:

- What climate change related factors make farming communities in the Bole District more vulnerable to malaria?
- How much do the farmers' households spend directly and indirectly, to securing health care per malaria episode?
- What proportion of farmers' household income is spent on malaria treatment because of climate change?



Methodology: The model used to analyse the climatic determinants of households' vulnerability to malaria was the multiple linear regression model. The direct cost was recorded on the questionnaire as reported by the respondent; in the case where respondents could not recall the specific amounts, lump sums will be recorded. Where receipts of purchase are available, they will be cross-checked with the verbally reported figures. All direct costs were then estimated to obtain the average and total values of cash expenditure on malaria episode to household. Malaria patients will be asked how much they would have earned a day if they were not disabled by the malaria episode. Similarly, caretakers will be asked how much they would have earned per day if they did not have to take care of the malaria patients (mostly children). The mean earnings per day will be reported by considering the prevailing agricultural wage.

Findings: The result reveals a clear evidence of change in temperature patterns during the period of record. Apart from the temperature, total direct cost of malaria care, number of people composing the farming household, support for malaria prevention, information about mosquitoes breeding and development, absenteeism at farm, and increasing of temperature are shown as main factors influencing the farming households' vulnerability to malaria. Furthermore, malaria care represent substantial portion of poor farming household income, direct and indirect cost of its treatment is affecting negatively the household budget.

Significance for practical solutions: Practically, my research will help the policies makers to put more means in malaria control among farming households since they are already threatened by climate change, resulting in income reducing.

ABSSUB-1343

SC 4.4 A global analysis of the climate sensitive disease: systematic review

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Research question: The main studies about climate change and health have shown the aggravation of disease incidence, as well as an expansion of the transmission area of infection diseases (IPCC, 2014). However, there is still a large diversity of Climate Sensitive Disease (CSD) lists, associated to many Climatic Variables in the world. This study intends to identify the CSD, Climatic Variables that are being studied and where they are happening (countries and continents).

Methodology: We did the research in July 2015. Studies were identified by searches of MEDLINE, LILACS, Scopus and Scielo. The searched terms used were "climate and disease and sensitive". We searched publications in English, Spanish and Portuguese. This systematic review aimed to include all published studies that included human outcomes attributable to climatic variables. Publications were analysed according to: i. Outcome, ii. Climatic Variable, iii. Methodology and iv. Local studied (country, continent and global).

Findings: In total, we identified 1008 publications. Among them, 144 were duplicates and 599 were excluded because they were related to veterinary, wildlife, vector ecology-and forest disease. At the end, 08 papers weren't found. In this way, we had 257 publications analysed.

We found 103 outcomes and 92 diseases (11 articles were related to hospitalization and mortality). The diseases with major frequency were: malaria (12%), dengue (9%), infectious diseases (4,5%), Respiratory



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SC 4.4 CLIMATE RISKS FOR INFECTIOUS DISEASES

diseases (4%), diarrhoea (3,6%), malnutrition (3,3%) and vector borne diseases (2,6%). In total, 18 publications didn't indicate a specific outcome, just discussed the human health prejudice according to certain climatic conditions. Regarding climatic variables, Temperature was presented in 115 studies, representing 26% of all studied variables. The other most studied variables were: precipitation, extreme climatic events, humidity, seasonality, El Niño, warm wave and extreme temperatures. According to the results obtained regarding places studied, 43 publications considered the Global analysis about climatic impacts and 20 of them didn't indicate a specific place. Except for these publications, the countries with the most studies were: United States (19), China (14), Brazil (13) and Australia (11). The large Brazilian presence can be related to the search in Portuguese. The spatial analysis of the local of studies and origin of researches can show that, although there are more studies made in developing countries than developed countries, there are more researches from North America and Europe.

We also analysed the association between outcomes versus climatic diseases versus places studied.

Significance for practical solutions: The systematic review permitted to identify pattern of studies related to Climatic Sensitive Diseases in different world regions. Although results indicated study gaps, they also showed regional concern and can guide priorities of decision making.

ABSSUB-1327

SC 4.4 Understanding health in the face of global change: towards a vulnerability framework

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Research question: A failure to address social and environmental drivers of ill health increasingly threatens ecosystems and human wellbeing. Advocates of 'Planetary Health' call for new research to advance health and environmental sustainability, tackle health inequities and improve the capacity of health systems and populations to deal with global change. For instance, health impacts associated with climate change, land degradation and urbanisation require examination of complex social and ecological interactions. Extending vulnerability concepts, which have been widely applied to understand climate change impacts, to examine health and wellbeing offers opportunities to conceptualize health risks such as emerging disease outbreaks, expansion of neglected tropical disease or changes in nutrition in the context of global change.

Methodology: Opportunities and obstacles to applying vulnerability concepts to study health challenges are investigated, using examples focusing on vector borne diseases such as malaria, dengue and leishmaniasis in diverse geographical regions. In particular, vulnerability to the direct and indirect health impacts of climate change in the MENA region is explored. Building on these observations a framework for health vulnerability analysis in the context for global change is presented.

Findings: A range of examples illustrate how vulnerability analysis can improve understanding of ways that populations experience a range of health threats by considering dimensions of exposure, susceptibility and coping or adaptive capacity. Our vulnerability framework can be used as the basis for further analyses that aim to increase understanding of complex health threats associated with global change.

Significance for practical solutions: Decision-makers require relevant information on vulnerability trends in order to make long-term planning decisions to promote health and develop effective mitigation and



adaptation strategies. The examples described here illustrate how vulnerable populations and places can be identified in order to better manage health threats and support policy-makers in better targeting of resources and interventions. These outputs can support cross-sector objectives that promote human health while ensuring ecosystem integrity in a dynamic and changing world.

ABSSUB-439

SC 4.5 Updated evidence about the health effects of climate change in the who european region

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Research question: How is the scientific evidence about health effects of climate change in the WHO European Region developing? As all over the world, the climate in the 53 countries comprising the WHO European Region, is changing. Temperatures are increasing, as are the frequency and intensity of extreme weather events including heatwaves, floods and wildfires and these trends are projected to continue under the most likely climate change scenarios. While the general pathways of health effects of climate change have been identified through evidence from all over the world, the specific and more recent evidence for health effects of climate change in the WHO European Region has been reviewed.

Methodology: A comprehensive literature search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) methodology. The search was designed to identify recent research papers relevant to the effects of climate change on health in the WHO European Region. Four search algorithms were designed for use in the PubMed and ScienceDirect databases, allowing a basic search as well as searches specific to different health outcomes and risks.

All identified studies assessing the effects, observed or projected, of climate-related impacts on health in Europe were considered for inclusion in this review. Studies were limited to those published in English from 2007 onwards.

Findings: The initial search performed using the four search algorithms in PubMed returned –after removal of duplicates- a total of 6,550 results, with an additional 2,740 identified using ScienceDirect. First screening (by way of automatic filters in PubMed and manual screening of ScienceDirect search results) returned a total of 631 papers. Second screening applying established eligibility criteria, assessment of abstracts and assessment of full text versions excluded another 515 articles. An additional 311 studies were identified from the hand search, leaving a final total of 147 studies included for review.

Significance for practical solutions: For research and policy making the constant review of evidence is crucial. This review has shown that evidence for climate related health effects of the changing climate is growing also in the WHO European Region, further underlining the importance of quickly taking sustainable action to protect health. This work has also shown that systematic reviews of all health effects of climate change, even when limited to a specific region, are getting increasingly complex. New methods to manage the growing body of scientific literature, maintain and update the knowledge about impacts, health effects and suitable responses are needed.



ABSSUB-1488

SC 4.5 Drinking Water Salinity Associated Health Crisis in Coastal Bangladesh

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Research question: Bangladesh has been identified as one of the most water insecure countries to the predicted impacts of climate change and sea level rise, where salinity intrusion is considered to have serious implications for domestic water management and public health provisioning. Ground water is the major source of drinking water in Bangladesh and there has been a continuous shift from unconfined to deeper confined aquifers as major point of extraction. Salinity has been reported to be of higher concentration above safe permissible limit in many coastal areas, however, there is very limited study done to assess drinking water quality and associated health hazards in public domain. This study, carried out under the framework of ESPA Delta project, tried to assess the drinking water salinity status of the coastal population and associated health hazards, particularly in terms of increased blood pressure.

Methodology: Data from a cross-sectional household survey covering seven socio-ecological systems (SESs) in the South West and South Central regions of coastal Bangladesh, an area highly vulnerable to the impacts of climate change and associated sea level rise, has been used as study area. Three rounds of household survey had been carried out after four months intervals, covering the timeframe of February 2014 to 2015. Drinking water sample and blood pressure of one eligible male and female member have been collected for randomly sampled 1500 households along with the questionnaire survey. Salinity of drinking water samples has been tested with HACH sensION5 Electric Conductivity meter and blood pressure has been measured with OMRON M2 Blood Pressure monitor by trained personals.

Findings: Among the 7 SESs, inter-seasonal shifting of sources is only prominent in 2 SESs and about 80% of survey respondents are dependent on groundwater for drinking purpose. It was found that, salinity in drinking water of deep tubewell water is higher than the safe permissible limit of 1000 mg/l in 4 SESs round the year. More than 20% of surveyed male and female respondents exhibit blood pressure in hypertensive and pre-hypertensive range in all three rounds with higher percentage of female respondents in both categories. With analyzing spatial and temporal distribution of drinking water salinity in 7 SESs, the study also tried to see association with blood pressure. Prevalence of hypertension was found to be statistically significant in 2 SESs for male and in 3 SESs for female respondents. The study further divided the water salinity level into 3 categories and it was found that both pre-hypertensive and hypertensive stage blood pressure increase with increase of salinity level in drinking water.

Significance for practical solutions: Coastal communities of Bangladesh are at the forefront of climate change and this study is expected to generate knowledge with important policy implications considering public health and water resources management.



ABSSUB-484

SC 4.5 Climate Threats and Health Impacts in Informal Urban Settlements: Enhancing Community Resilience

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Research question: This paper identifies local climate threats and correspondent health impacts, using a case study involving informal urban settlements in the city of Shashemene, Ethiopia. It additionally conducts an impact evaluation of a Biogas, Water Hygiene and Sanitation (BWAHS) development intervention to assess to what extent this is instrumental in reducing health vulnerabilities to current and future climate change. Whilst it is widely accepted that changes in climate will severely affect Least Developed Countries (LDCs), there is still uncertainty as to which specific climate threats are likely to affect vulnerable urban communities in LDCs, how livelihoods are affected due to climate variability and change, and the extent to which BWAHS development interventions can address, and possibly reduce, health vulnerabilities to climate change.

Methodology: The proposed framework employs a mixed methodology to be applied at community-level, including both qualitative participatory methods (using the adaptation tool CRiSTAL) and a quantitative (quasi-experimental) assessment of the effect of intervention using matching techniques. The research involves two waves of original data collection, both of which involved household surveys (N=400).

Findings: The findings of this research confirm that the majority of the threats faced by the informal urban settlements assessed are related to climate variability, and change. It finds that, contrary to what is indicated by national and international authorities, flooding is indeed a serious risk in the two settlements assessed, with consequent health impacts being neglected by current policies. It finally confirms the importance of BWAHS development interventions to increase community health resilience in the informal urban areas assessed, with a key role played by training in positively affecting key public health indicators, such as reduction in typhoid and increased self-assessed health.

Significance for practical solutions: With many BWAHS programmes being implemented at national level, often funded by international development funds, this research adds useful insights into current practices, and improvements in the practical implementation that could enhance both effectiveness of interventions and community resilience to climate change.

ABSSUB-1570

SC 4.5 Climate change: addressing heat-health vulnerability in rapidly urbanising regions of Western India

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Research question: Heat can adversely affect health through multiple pathways, and heat early warning systems and heat response plans have been found to reduce these impacts in several developed country settings. After a deadly heat wave hit Ahmedabad in 2010, the city launched India's first Heat Action Plan (HAP), a combined early warning system and heat preparedness plan, 2013. The objective of this study is to



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SC 4.5 IMPACTS ON HEALTH IN A CHANGING ENVIRONMENT

assess the HAP's impact on mortality during 2014, its first particularly hot year.

Methodology: Daily all-cause mortality data was obtained from Ahmedabad's registrar of births and deaths for the city's hottest months, March to June, in 2010 (pre-HAP) and 2014 (post-HAP). Daily mortality rates were generated using population estimates. Associations between average daily mortality rates and daily maximum temperature measured at the Ahmedabad airport were calculated. The relationship between maximum temperature and average daily mortality rates observed for the summer of 2010 was used to estimate mortality for 2014 and compared with observed temperature-associated mortality rates. The difference between estimated and observed mortality in 2014 were compared.

Findings: 2014 was a warmer year than 2010 with three heat wave periods, though they occurred later in the summer than the prolonged heat wave of 2010. The number of hot days during 2014 when temperature remained above 44°C was 16 days as compared to 8 days in 2010. A time-series shows a linear correlation between mortality and temperature with a threshold at around 40°C where mortality increases steadily. The slope of the line associating maximum temperature and average daily mortality above 40°C was lower in 2014 than in 2010. All-cause mortality was lower in 2014 (post HAP) by 11% for the entire summer and by 18-31% during heat wave periods.

Significance for practical solutions: The relationship between temperature and average mortality changed after the HAP was implemented and mortality rates were reduced, particularly at higher temperatures. Though the reduction cannot be specifically attributed to the Ahmedabad HAP, the increased awareness and early warnings may be responsible for the reduction in deaths.

ABSSUB-726

SC 4.5 The effects of climate change on health: risk assessment for the Dutch National Adaptation Strategy

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Research question: The Dutch government will launch an updated National Adaptation Strategy (NAS) in 2016. The National Institute for Public Health and the Environment was commissioned to perform an integrated risk assessment of potential health effects of climate change to support the development of the NAS.

Methodology: A system approach was used to evaluate the health risks with experts and stakeholders. The so-called 'Delta-scenarios' were used, that combine climate change scenarios with scenarios for socio-economic developments including urbanisation, migration and population ageing. Simultaneously, five other sectors have been evaluated for the NAS, using the same methodology: transport, ICT, nature, agriculture and fishery.

Findings: Climate change can affect public health in the Netherlands. In certain circumstances, the consequences could be significant. Heatwaves, which may cause mortality rises of approximately 13 per cent, may become more frequent. Senior citizens and people with chronic diseases are particularly susceptible. The effect of extreme temperatures is greater in the urban areas. Urbanisation and population ageing will reinforce the heat wave effects. It is not yet clear whether milder winters will reduce mortality. Higher temperatures could encourage trees and plants to bloom earlier in the year, and may allow the establishment of new allergenic species such as ragweed. The hay fever season will then be longer – perhaps extending



through much of the year by 2050. Heat stress and allergic reactions will be exacerbated by air pollution. Climate change is just one of many factors which can influence the incidence and prevalence of infectious diseases. It is not yet clear how these factors relate to each other. Some researchers believe that social and economic factors, such as globalization, are of greater significance. An outbreak of an infectious disease can have a serious societal impact. It is therefore essential to respond to potential threats promptly, and this demands effective monitoring. The effects of climate change in the transport or ICT sector could affect the availability and quality of health care provision.

Significance for practical solutions: The system approach shows that alongside climate change, many other factors can influence public health. Therefore, it is important to combine climate measures with those in other policy areas. Introducing more greenery to the urban environment, for example, will not only offset the effects of climate change but will also create a more pleasant living environment. Citizens can take measures themselves to adapt to climate change. It falls to the government to inform the public about those measures. An example is the Dutch 'Heat Plan'. If government policy is to respond to climate change effectively, it is important that all developments are closely monitored, for instance in the regular Dutch Health Public Health Forecasts.

ABSSUB-1568

SP 4.1 Climate change and infectious diseases in China: are we ready?

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Research question: Climate change will continue to put severe threat to the population health including infectious disease transmission, especially for China, the largest developing country with diverse weather patterns and different socioeconomic development levels. The primary aim of this report is to assess that, under climate change scenario, what are the efficacy of infectious disease prevention and control programmes, including the robustness and sensitivity of disease surveillance systems in China? How do health professionals respond to the infectious disease outbreak? What levels of health education the community needed?

Methodology: A questionnaire survey and qualitative interview have been conducted in China among the health professionals to understand their perceptions about climate change and infectious transmission, to find existing policy and guidelines, to examine the current capacity to meet such challenge, to identify the gap and to explore further actions.

Findings: The results showed that a majority of the Centre for Disease Control and Prevention (CDC) staff were aware of the health risks from climate change, especially its impacts on infectious disease transmission such as dengue, malaria and Hantaan virus infections, and believed climate change might bring about both temporal and spatial change in infectious disease transmission patterns. It was thought that adaptation measures should be established including: strengthening/improving currently existing disease surveillance systems and vector monitoring; building CDC capacity in terms of infrastructure and in-house health professional training; development and refinement of relevant legislation, policies and guidelines; better



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SP 4.1 EARLY WARNING SYSTEMS IN PUBLIC HEALTH

coordination among various government departments; active community engagement in infectious disease interventions; and collaborative research with other institutions.

Significance for practical solutions: Informed by an extensive body of literature and current research, recommendations on the way forward for infectious diseases control and prevention under the scenario of climate change have been made. These may prove helpful to decision makers and health professionals involved in climate change adaptation and future planning for disease outbreaks in China and neighbouring countries.

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**5. ECOSYSTEMS AND
ECOSYSTEM BASED ADAPTATION**





ABSSUB-573

SC 5.1 The contribution of ecosystem services to human resilience: a rapid review

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Research question: Use of the concept of resilience is growing rapidly in both policy and academic circles. As a result, there is little agreement on how resilience should be defined and consequently measured, not least because resilience may differ depending on context, space and time. At the same time, there has been increased interest in the past decade in approaches that link ecosystems with the benefits they contribute to making human life both possible and worth living. The Millennium Ecosystem Assessment, published in 2005, aimed to provide scientific information for decision-makers on the consequences of ecosystem change for human wellbeing, but there have been very few linkages made to human resilience. Responding to this gap, this rapid review summarises the extent of this evidence, framed around the questions:

1. How do ecosystems contribute to human resilience?
2. How can we measure/quantify the value of ecosystems in building resilience?

Methodology: The review captures key academic and grey literature linking Ecosystem Services (ES) and resilience through the use of initial searches on databases using search protocols. This was followed by a processes of snowball sampling and recommended readings from the panel of international experts who generously gave their time for the study. The review does not attempt to be comprehensive or systematic, but rather to provide a rapid assessment of the state of evidence on the linkages between, and measurement of, ecosystems and human resilience.

Findings: Frameworks that link ecosystems services and human resilience are still nascent and the evidence is patchy. The evidence is especially poor when considering the contribution of ecosystem services to the specific processes of building resilience in human systems, such as enhancing flexibility, diversity, cross-scale linkages, safe failure, or self-organisation.

When linked to resilience outcomes, there is greater evidence that ecosystems provide significant contributions to basic needs for subsistence, wellbeing, social capital and livelihoods. Ecosystem services have also been shown to reduce exposure to natural hazards, which also contributes to resilient outcomes. This has supported the case to invest in ES through mainstreamed development approaches in the fields of disaster risk reduction and climate change adaptation.

Significance for practical solutions: There is a strong economic case for investing in ecosystem services for human benefits. The majority of studies find that the costs of ecosystem-based approaches are far outweighed by the benefits. The relative contribution of ecosystem services to human resilience outcomes is much harder to assess. Clearly, many interventions contribute to human resilience outcomes, but it is difficult to differentiate how much ecosystem services contribute to a specific outcome.

Governing sustainable ecosystems based on resilience characteristics in linked social-ecological systems is also important to consider if ecosystem services are to deliver human resilience outcomes.



ABSSUB-978

SC 5.1 Ecosystem based shrimp aquaculture as adaptation option in southwest Bangladesh

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Research question: Is the ecosystem based shrimp aquaculture a suitable livelihood option for climate change adaptation in southwest Bangladesh?

Methodology: This study considered southwest coastal area of Bangladesh (Satkhira, Khulna and Bagerhat districts). Two upazilas from each of these three districts were selected. Besides, the study area was divided in six zones of salinity. A total of 240 shrimp farmer interviews, 60 KI interviews, and 24 FGDs was conducted which were equally distributed in these salinity zones. Purposive sampling method was used to select respondents for questionnaire survey.

Findings: The study reveals that the production rate of shrimp varies in different salinity zones and it is better in the areas with optimum salinity for shrimp aquaculture. Moreover, sites having better ecosystem service have better production rate. In last decade, there has been a gradual decrease of yield due to loss of ecosystem services and abrupt climatic changes (increase in temperature, rainfall and salinity). As a result, farmers are adopting shrimp mixed aquaculture (shrimp with prawn, fresh water fishes, crab, paddy etc.) which increases profit by about one third of shrimp monoculture. The farmers associated with shrimp aquaculture are not well aware about the causes of low production and its relation with abrupt climatic changes. Although, the Department of Fisheries of Bangladesh (DOF) has field level activities to aware farmers, these efforts are not enough to support large number of farmers involved in shrimp aquaculture.

Significance for practical solutions: This study conducted in the southwest coastal Bangladesh assessed the temporal changes in the yield of shrimp in terms of the changes in ecosystem services and the suitability of shrimp mixed aquaculture as livelihood adaptation option in the context of climate change.

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SC 5.1 Europe's Ecosystem Services: integrated assessment of combined climatic and socio-economic futures

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Research question: Climate change will lead to significant impacts on Europe's Ecosystem Service provision. The severity of these impacts will vary depending on both the climatic scenario, and the socio-economic future priorities – including the adaptation options taken up. This paper explores different socio-economic scenarios, including adaptation options, under different climate scenarios. It uses a spatially explicit integrated modelling approach which explicitly addresses the synergies and trade-offs between different land



use sectors. It addresses the research question: what is the range of potential impacts on the provision of a broad range of ecosystem services under the different futures?

Methodology: The CLIMSAVE integrated assessment platform is used to quantify both ecosystem services and land use changes across Europe. The platform integrates models for a number of different sectors including food, forestry, water, flooding, urban development and biodiversity. It provides indicators for a number of ecosystem services directly (food, water and timber provision, atmospheric regulation, biodiversity existence/bequest, landscape experience and land use diversity) as well as changing patterns in land use. Matrix-based approaches are applied to the land-use outputs in conjunction with the existing integrated modelling outputs to enable a wider range of ecosystem services to be evaluated.

Findings: Climate change has considerable impacts on future ecosystem service provision (particularly water provision). However, Socio-economic changes are equally important considerably altering patterns of service provision: in dystopian future societies there is a need to focus on food provision which has detrimental impacts on other ecosystem services. Significant opportunities are offered by the uptake of adaptation options, but these will still require trade-offs to be made particularly between agriculture- and forestry-related services. There are also clear spatial impacts with some trade-offs between regions (particularly South-North) also being identified under some scenarios.

Significance for practical solutions: Coordinating adaptation across regions and sectors will be essential to ensure that all needs are met: a factor that will become increasingly pressing under dystopian futures where inter-regional cooperation breaks down. The Integrated assessment stresses the need for the constant consideration of the trade-offs between ecosystem services: it is highly important to take account of complex cross-sectoral interactions under different future scenarios when planning adaptation responses.

ABSSUB-1404

SC 5.1 Role of biodiversity and ecosystem services in climate adaptation and mitigation strategies

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Research question: As the climate changes, biodiversity will be affected by extreme weather patterns and events. The same is true for ecosystem services, where the provisioning of services could be diminished due to biodiversity loss. There are several studies assessing the effects of climate change on biodiversity, however limited knowledge exists on the interactions between climate change and land use change and their impacts on biodiversity. Furthermore, assessing such impacts leads to identify adaptation and mitigation measures where biodiversity plays an essential role in coping with climate change. This paper focuses on identifying the interactions between climate change and land use change and addresses the question: How can biodiversity, through the provisioning of ecosystem services, be included in adaptation and mitigation strategies contributing to reduce climate change impacts?

Methodology: As drivers and pressures tend to interact in synergistic ways, a literature review is conducted to identify interactions between climate change and land use change and their impacts on biodiversity. Results of such review are tested in GLOBIO3 model. Besides the quantification of these impacts, GLOBIO3 will also test the appropriateness of adaptation and mitigation strategies. The design of these strategies adopts biodiversity and the provisioning of ecosystem services as the main elements to cope or reduce the impacts of



climate change.

Findings: Results on drivers interactions are presented as changes on the mean species abundance (MSA) indicator, which are compared to previous MSA values where no drivers interactions were considered. Strategies promoting the expansion of land use systems with numerous ecosystems goods and services (e.g. scrublands and agroforestry) are assessed in GLOBIO3. For example, a strategy based on the management of cultivated areas by decreasing crop areas in Europe (i.e. cropland reduction in 5% and 10% relative to baseline conditions) allows to increasing areas where forests can re-grow. Well-known services provided by forests and its biodiversity are discussed in more detail. Moreover, results show that by decreasing crop areas the values of mean species abundance increase.

Significance for practical solutions: The outcomes of this research provide a more integral understanding on the role biodiversity and ecosystems play to adapt human society to climate change, simultaneously enhancing the understanding on interactions between global-change drivers and their impacts on biodiversity.

ABSSUB-610

SC 5.1 Payment for ecosystem services – paying farmers for using farmland for flood control

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Research question: Northern Europe experiences an increasingly wet climate, leading to more frequent and severe fluvial flood events. Ecosystem-based Adaptation (EbA) is becoming recognised as a valuable yet under-utilised means to alleviating negative effects of a changing climate. This however, necessitates a new and different collaboration between land-owners and stakeholders interested in protecting urban structures and as a result, novel ways of understanding and organising EbA emerge across Europe. One example, using the approach of Payment for Ecosystem Services (PES) is presented in this paper.

Methodology: Farmers along the second longest watercourse in Denmark could be instrumental in allowing flooding on farmland to protect urban infrastructures. We conduct a choice experiment among farmers located in vicinity to the river 'Storåen' in order to assess their willingness to accept a contract that would allow the local municipality to periodically flood farmland in order to avoid or limit urban flooding from Storåen. The experiment aims to estimate the costs of getting farmers to participate in the scheme, which would represent (some of) the costs of reducing climate change problems in the town of Holstebro. In a number of choice occasions, farmers were asked to select between either no contract or contracts characterised by a set of positive and negative attributes, including a whether or not to require specific flood resistant crops or not; whether to allow for a compensation in case of crop loss or not; the type of negotiation situation and finally the level of payment to the farmer for including his/her land in the inundation control scheme.

Findings: Results indicate that farmers on average would prefer not to enter a contract. If they were to agree on a contract they would prefer a compensation for lost crops; to negotiate collectively with other farmers and as expected would prefer higher rather than lower yearly payments. Surprisingly, the data did not show a significant preference for or against a requirement to grow flood resistant crops. A contract that would allow for compensation and based on individual negotiation would on average require a yearly payment of 309euro/ha.



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Significance for practical solutions: This type of analysis investigates attitudes and preferences of land owners, which are essential when dealing with Ecosystem-based Adaptation. Past experience shows that without the agreement of land owners or the appropriate compensation level, voluntary schemes will not function at the necessary scale.

ABSSUB-1354

SC 5.2 Effectiveness of local sand nourishment for safety and ecosystem preservation

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Research question: The building of dykes, dams and barriers intended to protect the human population have led to the transformation of the Eastern Scheldt (the Netherlands), once an open estuary, into a saltwater basin behind a semi-open storm surge barrier. Recent studies show a strong decrease of intertidal areas, due to an imbalance between the basin morphology and the tempered tide. This has led to habitat loss and increasing wave forces on the dykes. To mitigate the stress on ecosystem services, the government obtained a learning-by-doing approach focusing on nature-based solutions. Pilot studies with local sand nourishments were launched. The largest of these is the Oesterdam sand nourishment, where in November of 2013 a total of 350.000 m³ of sand was placed at the tidal flat and artificial oyster reefs were built to slow down the erosion process. In this interdisciplinary project, the effectiveness of the approach is studied. The projects main questions are: (1) How durable is the sand nourishment? Will it allow to postpone dyke reinforcement for 25 years? (2) To which extend will the nourishment help maintain the intertidal ecosystems, and what are the parameters controlling the ecological development? (3) Does the nourishment overall result in a cost-effective solution?

Methodology: To evaluate the durability, morphological changes are monitored in an area of 200 ha with a DGPS. To find a relationship with the morphological changes and hydrodynamic forcing, parameters are measured at a near-shore station, and are supported with short measurement campaigns. A morphological model is developed to better understand and predict the general development. Ecological functionality is being investigated at 15 field locations, where the temporal development and relationships between physical parameters is monitored. The diversity of hard substrate species are explored on the artificial reefs. To get an additional understanding of the biophysical interaction flume experiments are executed to quantify biotic effects on sediment erodibility.

Findings: In the first six months changes were obvious in the morphology of the nourishment, after which it became more stable. The model and field measurement results demonstrate that the area is dominated by wave action, except for a local drainage system. The morphological model will be used to further investigate the understanding of the system. The benthic organism show a fast recovery in the first year, especially for cockles that occur more in the sheltered areas, which is beneficial for the bird populations. Flume experiments



show that the effect of benthos on sediment erodibility depends on animal densities and sediment composition. Biodiversity on the artificial oyster reefs varies between reefs and organisms.

Significance for practical solutions: This study will provide the government important knowledge concerning the effectiveness of local nourishment as a solution against the loss of intertidal areas. The results will also be used to improve future nourishments designs.

ABSSUB-221

SC 5.2 Adaptation in dryland ecosystem: sivopastoral farmer led initiatives in semi-arid region of Pakistan

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Research question: There are more than 3 billion people globally living in drylands that cover 40% of earth's surface; ROBIN (2002). In Pakistan, the situation is severe with 75% of the country's area receiving less than 250 mm of annual rainfall; PMD (1998). Drylands in southern Pakistan are home to communities living in poverty and depending on livestock rearing for their livelihood. The subsistence agriculture is losing its importance under the effects of climate change i.e. uncertain rainfall and very low productivity. To fill the livelihood gap, local communities are increasing their livestock herds. Thus pressure on silvo-pastures is increasing resulting in degradation of natural resources and loss of soil fertility, a fact that adversely affects the livelihood of communities. These climate based ecosystem challenges have remained unanswered since long.

Methodology: The Farm Forestry Support Project (FFSP) of the Intercooperation (IC) and Swiss Agency for Development & Cooperation (SDC), initiated collaboration with local pastoral communities to pilot adaptation measures in 2010 in extreme dry region of Karak. Major elements of these measures included the strengthening of the silvo-pastoral system using hillside ditches and sand dune stabilization techniques. The objective was to harvest, conserve and use rain water for recovering vegetation and increase productivity of the area with minimum cost and hence support livelihoods. The activity was carried out with participation of civil society organisations and farmers' associations.

Findings: The results recorded in 2015 showed a profuse plant growth in terms of trees, shrubs and grasses with a potential to provide timber, fuel wood and fodder for livestock. Maximum harvesting of rainwater and conservation of moisture also resulted in growth of natural grasses and shrubs. Within a short period of 5 years, plant growth in height and diameter of 6 meters and 20 centimetres respectively was recorded. The average vegetation cover of 45% and increase in soil organic matter and nitrogen content was also recorded. All this happened with a minimum cost of US\$ 82 per hectare. The rejuvenation of wells in few cases was an additional positive affect of the activity. On the other hand, an annual income of US\$ 735 per hectare from *Saccharum spontaneum* planted in sand dunes was a real benefit to farmers against other land-uses in sand dunes.

Significance for practical solutions: The results of these pilot activities have provided options for adapting to severe and changing climatic patterns in the dryland ecosystem leading to providing a sustainable livelihood



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base. The involvement of pastoral communities is essential for sustainability of the system. Keeping in view the wide pattern of natural resource use (particularly the open grazing system in many arid countries of the region) it can be recommended to apply a landscape approach beyond the boundaries of a single community or land-ownership.

ABSSUB-366

SC 5.2 Adapting communities to climate change vulnerabilities: a case of Mweru-Luapula fishery, Zambia

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Research question: Climate Change adaptive development of fisheries plays an important role in improving food supply and in increasing the earnings of rural population. However, sustainable and climate change adaptive fisheries can be guaranteed only when fisherpersons are introduced to climate-adaptive socio-economic livelihoods and community-based adaptation options as alternative source of income so that fish population can be allowed to increase. One way of applying this climate adaptive and alternative development approach is to encourage and introduce fisherpersons to climate adaptive exploitation of biodiversity and ecosystems as alternative source of services and livelihood. Basing on the Applied Research which was conducted in the six villages of Mweru-Luapula fishing community, in the period between 2014 and 2015, this paper tries to respond to the question as to how the community can address the impact of climate change on the fishery ecosystems and their livelihood.

Methodology: Mweru-Luapula fishery is located in Nchelenge district of Luapula Province in the North-Western part of Zambia. The fishery was identified as the study area and project location because it is one of the largest vulnerable fisheries with over five thousand (5000) fishing sites, camps/villages found along the banks of the Lake Mweru-Luapula and its lagoons and islands. The Department of fisheries in the area indicates an estimated total population of 30,000 fishing habitants. The paper discusses the designed research approach that targeted the fishery community population which was stratified and systematically sampled in Thirteen (13) wards of the district. The presentation then outlines the major data collection methods used which included; selective literature review, direct observation and Focus Group Discussions in Six villages. The research also involved household and institutional interviews. This was followed by analysis and interpretation of the collected data.

Findings: The paper further shares the action oriented research findings on the climate change anticipated impacts on these fishing communities and then suggest adaptive measures that they can adopt. The paper will, to an extent outlines key adaptive livelihood opportunities that were identified by the community themselves during the focus group discussions.

Significance for practical solutions: The paper will further discuss the conceptual framework appropriate for the study on the effects of climate change on the socio-economic livelihood and fishery ecosystems. In conclusion, the presentation will share programmatic technical and policy recommendations, including key information resources for climate response strategy for such fishery communities in Zambia and in other similar vulnerable fishery communities.



ABSSUB-940

SC 5.2 Mobility as an adaptation response in Samburu, Kenya: gendering the debate

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Research question: The Samburu landscape in Kenya, that ranges from a harsh desert to the foothills of Mt Kenya presents a scenario of rapid peri-urbanisation. Mobility is a response to increased environmental degradation and climate variability. It has, however, been assumed, that mobility is a preserve of men, often pastoralists moving with their livestock. This research paper will explore the gendered nature of current mobility patterns and how this impacts on gender relations and wellbeing. The research will examine changing relationships in two respects: a) when men move and women are left behind to survive in their rural homes; and b) when women too begin to engage with short-term movement to small towns and peri-urban contexts to engage with trade.

Methodology: The research adopts a mixed methods approach. It will include baseline data from a few settlements representing different environmental and climatic conditions - desert (arid), semi-arid and semi-humid, and covering a spatial range from protected areas and rural settlements to the peri-urban and urban. The initial baseline and community mapping will be followed up by in-depth interviews to provide insights into the gendered nature of mobility patterns.

Findings: While too early to report on concrete findings, preliminary evidence suggests that mobility patterns in the Samburu landscape are not just restricted to men and livestock. Rather, women too have been building trade links with smaller towns and peri-urban centres. Secondly, there are clear patterns of movement that can be identified both spatially and temporally and these are gendered in terms of the livelihood activities as well as material cultures. Finally, it is clear that even though the landscape is often difficult to navigate, there are linkages between different climatic and environmental zones, with changes in one potentially impacting on the other.

Significance for practical solutions: By highlighting the temporal and spatial complexity of mobility patterns and their gendered nature, the research has significant implications for policy and planning. It can ensure that households are not considered as unitary entities, rather their diversity and variations in strategies taken into account. This will help move towards ensuring community wellbeing.



ABSSUB-249

SC 5.2 Floating garden: climate smart technology for food security in flooded ecosystem of Bangladesh

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Research question:

- * Is the floating garden technology having innovative, climate smart and eco-friendly?
- * Is the system able to enhance food security and income generation of small households in flooded ecosystem of Bangladesh?

Methodology: The research works were conducted by survey study followed by adaptation trial on indigenous floating garden technology. The survey was done through interview schedule and focus group discussion among the various categories of sample stakeholders (farmers, traders, government and non-government organisations) in flooded area of three southern districts (Gopalganj, Pirojpur and Barisal) of Bangladesh, and adaptation trials were executed at Regional Agricultural Research Station, Barisal of Bangladesh Agricultural Research Institute during 2013-2015 to evaluate the performances of floating garden in terms of food security, income generation, adaptability and environmental sustainability.

Findings: Research findings reveal that the local farmers have been practicing "floating garden" (locally known as "Dhap chash") since two centuries based on their traditional knowledge and experiences as adaptation practice for food security and income generation under flooded ecosystem. The floating bed is built up on flood water (>1 metre deep) using natural aquatic weeds (like water hyacinth, water lettuce, dulalilata, shaola etc.). The farmers usually grow seedlings, vegetable and spices crops on submerged floating bed following organic system. The average yield and net return of vegetables were 380 kg/100 m² bed. The system provides fresh vegetables particularly ensure the food security of small households. Besides, average of 4500 vegetable seedlings was grown during a monsoon season (June–October). The adaptation trials also showed the yield potential of the floating system. The growers sold their farm products at local market and earned US\$ 230/bed/season. Moreover, the decomposed floating beds were used as well as sold as compost or organic manure for subsequent crop production.

Significance for practical solutions: The impacts of climate change like sea level rise, floods, salinity and cyclones are major threats for crop production in Bangladesh. A vast area of land remains fallow during monsoon season or even all the year round due to flooding, which hampers the food security particularly the small households in southern region of Bangladesh. However, as innovative and climate smart technology, the floating garden can easily be practiced for crop production in the flooded fallow lands by using natural resources. The practices are friendly to the ecosystem and biodiversity of plants. Moreover, millions of local people are directly or indirectly associated with different enterprises (like inputs supply, products marketing, transportation etc.) of floating garden practices for income generation. The technology is labour intensive farming system that creates equal participation of men and women. The system could be sustainable and adaptable to similar ecosystems for food security in Bangladesh.



ABSSUB-199

SC 5.3 Adapting whale watching to climate change – a case study from the east coast of Australia

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Research question: Whale watching is a billion dollar industry worldwide. One of the most popular species for whale watching is the Humpback whale (*Megaptera novaengliae*). The migratory corridors, feeding, resting and calving sites, which are used for whale watching may be influenced by changing ocean currents and water temperatures. Whales are responding through a shift in migration time, behaviour, abundance and distribution. How can the whale watch industry adapt to migration shifts and bad weather conditions?

Methodology: We used participatory modelling involving key stakeholders for the whale watching industry to develop a systems conceptualisation model for evaluating the potential effects of climate change on the whale watch tourism on the east coast of Australia. We integrated multiple drivers including climate change (e.g. length of season, temperature), policy (e.g. number of boats), ecology (e.g. number of whales age structure) and socioeconomic (e.g. number of tourists, fuel price) to evaluate the changes. The structure and the quantification of this model was provided by the stakeholders and a sensitivity analyses was carried out to help identify important intervention points for the industry.

Findings: Our analysis clearly showed that the whale watch industry in south-east Queensland is vulnerable to climate change to different extents but that there are multiple intervention points, especially in the economic and regulation sector. Methods used in this case study are applicable to other whale watching regions around the world.

Significance for practical solutions: Our research illustrates how a model can assist local tourism operators and authorities in making rational coastal zone management decisions. Our study also revealed a lack of management instruments to develop natural resource-based tourism in Australia.

ABSSUB-1234

SC 5.3 Evaluating the global potential of green infrastructure for reducing flood risk under climate change

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Research question: Climate change is expected to drive a significant increase in flood risk in many areas of the world. Its signal will interact with other non-climatic factors, including an increase in human exposure to flood prone areas due to population growth and urbanisation, together with changes in land use and management. These ongoing changes will place the lives and livelihoods of an increasing proportion of the world's population at risk. Such changes have already resulted in an increase in the number and economic cost of major flood events globally in recent decades; in the first half of 2015, eastern China alone has seen losses of \$18.4 billion after torrential rainstorms driven in part by El Nino. Development responses to both present-day



and projected future flood risks predominantly utilize investments in built infrastructure (e.g. dams, riverbank armouring) to mediate those risks. Yet many of these investments fail to adequately address uncertainties, resulting in climate-infrastructure mismatches that threaten to exacerbate rather than reduce flood risk. Such investments also often ignore, and can be highly detrimental to, the surrounding environment. This is a perverse outcome since natural infrastructure (ecosystems such as upland forests and floodplains) provide multiple mechanisms for mitigating the negative impacts of floods. As fundamental components of the hydrological cycle, ecosystems regulate overall water balance through evapotranspiration and directly mediate flood risk through flood water storage capacity. Hence, there is growing interest in the role that ecosystems can play in mitigating both current and future climate-driven flood risk.

Methodology: We use the web-based hydrological modelling system, WaterWorld, together with projections of future climate change-driven shifts in precipitation globally, derived from the CMIP5 ensemble, to evaluate changes in flood risk for the world's major cities and agricultural regions. The model quantifies upstream 'storage' by green infrastructure (forests, wetlands, grasslands, soil) of climate change-driven increases in precipitation, thereby reducing peak runoff and hence downstream flood risk.

Findings: Green infrastructure significantly reduces flood risk in several world regions where climate change is projected to drive increases in flood frequency and intensity. Hotspots include Southeast Asia and the northern Andes, where remaining large areas of forested land in particular, provide significant storage capacity, thereby mitigating flood risk to multiple major urban centres and core agricultural regions.

Significance for practical solutions: The green infrastructure identified in this global assessment represents a critical existing, as well as future buffer against flooding for hundreds of thousands of people and hundreds of millions of dollars' worth of assets. Sustainably managing these areas is therefore critical for reducing flood risk and its consequences for sustainable development more broadly in the coming decades.

ABSSUB-1102

SC 5.3 Adaptation by wide green dikes: opportunity to improve biodiversity along the coast?

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Research question: The foreseen effects of climate change lead to the challenge to reinforce the existing flood protection works along the Dutch Wadden Sea coast. The wide green dike concept, as applied along the German and Danish Wadden Sea coast, is identified as a cost-effective and flexible solution. Such a wide green dike may also strengthen the important landscape and nature values of the Wadden region. A wide green dike has a grass covered shallow sloped seaward face, instead of an asphalt or stone revetment, and merges into the adjacent salt marshes. Is there a difference in nature value between a traditional Dutch dike and a wide green dike?

Methodology: We analysed the vegetation composition on the seaward slope of the dikes along the entire Wadden Sea mainland coast. We looked at the vegetation at the dike toe, the middle of the slope, and close to the top of the dike. We then compared the vegetation on the dikes along i) the Dutch, ii) the Niedersachsen, iii) Schleswig-Holstein, and iv) the Danish Wadden Sea coast.

Findings: Our assessment revealed that there is indeed a difference in vegetation between traditional Dutch



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dikes and wide green dikes. Especially the older grass covers of the wide green dikes harbour many different grasses and forbs. Although the vegetation coverage of such species rich vegetation is in general somewhat lower than the coverage of traditional Dutch dikes, there were no signs of differences in erosion resistance. The observed root density was good (measured within the growing season). The majority of dikes in all four areas is maintained by sheep grazing. Especially in Germany, several dike sections together with the adjacent salt-marsh and mud and sand flats are in use as beach. These dike sections are mown frequently during the tourist season. At the toe of traditional Dutch dikes some sparsely vegetation is present on the stone or asphalt revetment, while at the toe of wide green dikes several typical salt-marsh species are found. However, when there is a wide, and high foreland present, no halophytes were found on the toe of wide green dikes. Furthermore, we found a difference in grass-species between Niedersachsen and Schleswig-Holstein. Many dikes in Niedersachsen are recently reinforced, and sown with a selection of fast growing and high-productive grass species. Therefore, the floristic diversity is low. In Germany, historically, the seaward slopes of reinforced wide green dikes were covered with salt-marsh sods.

Significance for practical solutions: The results demonstrate that wide green sea dikes can harbour species-rich vegetation and form at many locations a smooth transition from salt-marsh foreland vegetation into dike grasslands. Such wide green dikes may even form an interesting additional man-made habitat along the coast, which may form a window of opportunity for nature compensation, forthcoming from climate adaptation tasks.

ABSSUB-1089

SC 5.3 Vegetated foreshores as coastal protection strategy: coping with uncertainties and implementation

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Research question: Worldwide, hard structures are used as coastal protection measure. These structures are static and do not respond to changing boundary conditions like sea level rise and increasing storminess. Recently, the use of soft solutions in front of hard structures is more and more proposed – but not applied – as sustainable coastal protection measure. Promising Building with Nature solutions for flood protection, such as vegetated foreshores, inherently have a dynamic nature. Therefore there is a relatively large degree of uncertainty with respect to their contribution to flood protection. Moreover vegetated foreshores are multi-functional in combining flood protection with enhancement of biodiversity. Current governance arrangements fail to address these characteristics and this hampers innovation and implementation of vegetated foreshores in flood risk management. In this paper we propose a method – based on game theory – to arrive at governance arrangements that enable implementation of Building with Nature solutions. The central research question is: how to enable the implementation of vegetated foreshores for flood risk reduction?



Methodology: In this study we employ a multidisciplinary approach by combining governance knowledge regarding implementation with engineering, ecological and bio geomorphological knowledge. In order to arrive at governance arrangements cooperative game theory is used. Game theory provides insight in the dilemma that stakeholders are faced with in the implementation game and how contextual factors shape the behaviour of stakeholders. Cooperative game theory aims at formulating advice on how to play the game. One of the key concepts is the 'core' which elucidates the particular space where both the interest of the group of stakeholders as well as the individual stakeholders is secured. Ultimately the decision-space, or core, should match the technical aspects of the flood protection solution to allow for actual implementation. The technical aspects are covered in the ecological, bio geomorphological and hydraulic parts of our research. We analyse fundamental ecological and physical processes using field observations, flume experiments, hydrodynamic and morpho-dynamic modelling. This analysis forms the basis for a vegetated foreshore design. The vegetated foreshore design and the decision-space are matched using an iterative design cycle.

Findings: The project provides the knowledge, methods and tools required for the design and implementation of vegetated foreshores in flood management. It yields insight in implementation dilemmas and the possibilities for a technical design. We present a multidisciplinary method that contributes to enable implementation.

Significance for practical solutions: We present a ready-to-use and science-based method for stakeholders – including private sector, government and non-governmental organisations – supporting the decision-making on vegetated foreshore solutions for flood risk management.

ABSSUB-1230

SC 5.3 Protecting people and nature through Ecosystem-based Adaptation in the Atlantic Forest, Brazil

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Research question: How to promote Ecosystem-based Adaptation (EbA) from local to national level in Brazil's Atlantic Forest, in the context of bilateral cooperation projects?

Methodology: The project Biodiversity and Climate Change in the Atlantic Forest is coordinated by Brazil's Ministry of the Environment (MMA) in the context of Brazilian-German Cooperation on Sustainable Development. It seeks to promote Ecosystem-based Adaptation (EbA) through biodiversity conservation and restoration in networks of protected areas (mosaics). The project innovates in developing new tools and methodologies for considering risks of climate change and opportunities of EbA in land management instruments and processes. Pilot projects at local level provide essential input for public policies at national level that allow for mainstreaming of EbA. Prominent examples include Brazil's National Adaptation Plan as well as a proposal for a national plan on native vegetation recovery aiming at large-scale restoration. Sustainability of adaptation measures at local level is enhanced through intense capacity development activities in collaboration with academia and civil society.

Findings: In the Atlantic Forest, high fragmentation persists across remaining forest areas. Furthermore,



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extreme weather events such as droughts and heavy rainfalls have led to considerable socioeconomic consequences in recent years. Also, the region faces huge challenges regarding the supply of essential ecosystem services (e.g. water provision) in Brazil's megacities, such as São Paulo. Successfully reversing these trends in the Atlantic Forest requires intelligent solutions that combine climate change adaptation and biodiversity conservation. Information on local impacts as well as the degree of vulnerability of highly fragmented ecosystems is crucial, as well as increasing knowledge amongst local key actors and the general population. Challenges also include the need for easy-to-use tools for integrating climate change and EbA in land management instruments. Also, capacities of local actors urgently need to be strengthened. Public policies should integrate EbA and ecosystem services e.g. in directives and guidelines for land management. Then, implementing EbA-measures requires appropriate economic incentives. Finally, adequate governance structures and knowledge networks need to be built in order to support local efforts.

Significance for practical solutions: The project provides new responses to the above-mentioned challenges that are replicable in a great variety of contexts. It contributes to increasing resilience in Brazil's Atlantic Forest through its ample capacity development strategy and important practical insights for national policies. Step-by-step guidance for integrating climate change and EbA in territorial planning should be of great value for many adaptation practitioners. What is more, its multilevel approach proves to be thoroughly consistent with the objective of creating solid foundations, from local to national levels, to promote EbA-solutions.

ABSSUB-724

SC 5.4 Better Wetter: linking spatial adaptation to regional transitions

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Research question: Better Wetter concerns the testing and implementation of innovative land and water use to pave the way for spatial adaptation of the regional water system. This challenge is addressed by linking changes in the water management and associated land use to the development of (monetary or other) revenues for the regional community. The long term goal is to redevelop the regional water system of the 'Friese boezem' as a sustainable and resilient water system.

Methodology: The traditional form of water management, up till present one-sidedly directed towards the optimisation of agriculture, meets its limits. The high-quality agricultural sector thrives on traditional draining of the soils, but the long term and significant land subsidence which comes along with that, aggravates water management options. Therefore, an innovative approach is needed for flexible water management in new areas. This change is a huge step for local communities. Therefore we choose an approach where adaptation is linked to existing or future regional transitions, and local stakeholders are actively involved.

Findings: Spatial adaptation requires new areas, redesigned for flexible water management, to deal with water level fluctuations in the regional water system as a result of weather extremes. Better Wetter is testing and piloting these options. Ecologically, the (re)introduction of water level dynamics in segmented areas – but hydrological and ecological connected to the regional water system – is a major step as they replace the past seasonal flood pulse on system level. The possibilities for flexible water management are enlarged by introducing (ecosystem)services, offering revenues to the local communities. The combination of flexible



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water management with an ecological sustainable services open the way for new areas to the water system. Moreover, this functional combination act as a lever of change in water management. Better Wetter works on the development of revenue models for the region. This concerns for example the production of Cattail-products from polder areas in the region. By involving local entrepreneurs from the start in this approach, using and respecting their knowledge and skills, the development of new products and services gains broad support.

Significance for practical solutions: Better Wetter shows how spatial adaptation of the regional water system is stimulated when this process is linked to regional transitions involving local communities, and at the same has a significant impact on the sustainability and ecological restoration of the regional water system. In this presentation we show our approach and first results.

ABSSUB-899

SC 5.4 Selecting climate resilient tree species for forest restoration in the Himalayan region of Nepal

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Research question: Measurable species range shifts and changes in composition of forest vegetation in the Nepalese Himalaya have been already attributed to global climate change. This global driver of ecological change can act in synergy with proximate anthropogenic drivers to accelerate forest degradation. Because forests play an important role in providing vital ecological goods and services, including carbon sequestration, the Government of Nepal is encouraging forest restoration and sustainable management through various policy instruments including the recent Forest Policy, 2015. The reforestation programme must, however, consider the effects of climate change on the long term vulnerability or resilience of tree species, and adopt appropriate analogue forestry techniques that mimic natural forests with redundant ecological linkages that add resilience. For this, choice of species becomes paramount, and plantation should include species expected to thrive under future climate change scenarios.

Methodology: We used two complementary approaches to assess the adaptive capacities of tree species to inform a climate change-integrated approach to forest restoration and management. The first assessed the germination success of seeds of important tree species using a mechanistic Tree and Climate Assessment-Germination and Establishment Model (TACA-GEM) that simulates climate change conditions, and the second assessed the range distributions of the species under climate change scenarios using predictive species envelope models.

Findings: The results show that several tree species could undergo range shifts due to climate change. *Shorea robusta*, a species that dominates the lowland forests, may shift north along the river valleys, together with



several other major sympatric tree species. The mid-mountain tree species such as *Cinnamomum tamala*, oaks (*Quercus* spp.) and *Castanopsis* spp. do not exhibit extensive range shifts. The high mountain species (*Rhododendron* spp., *Pinus wallichiana*, *Abies* spp.) may encroach into the alpine zone. Results from the mechanistic model showed that the lowland species (viz. *Shorea robusta* and sympatric species *Adina cordifolia*, *Acacia catechu*, *Bombax ceiba*, *Dalbergia sissoo*, *Schima wallichii*, *Syzygium cumini*) had good germination and recruitment success under projected climate change simulations for the higher elevation subtropical areas; a result concordant with the predictive model.

Significance for practical solutions: Because of the complex topography in mountain systems that create climate microrefugia, selecting tree species for long term reforestation programmes should adopt an approach that triangulates macro-scale correlative climate envelope models with mechanistic approaches that consider the ecophysiological characteristics of the individual species, as well as the presence of climate microrefugia, and local knowledge. However, the uncertainties associated with climate change trajectories also call for monitoring of species survival, growth, phenology, and recruitment for adaptive management.

ABSSUB-1442

SC 5.4 A theoretical research review of forest law and customs in Bangladesh as local adaptation practices

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Research question:

1. What are the legal frameworks for efficient and effective management of forest resources in Bangladesh?
2. What are the local people's socio-cultural norms, customs and values pertinent to sustainable forest management in Bangladesh?
3. How both the two could be intertwined for risk informed sustainable forest management?

Methodology:

1. Reviewing forest management policies, Laws and Rules, Plans and guidelines in Bangladesh.
2. Data collection through literature review, Direct and indirect interview, group discussion on local people's wisdom, norms, customs, values and practice of forest management in Bangladesh.

Findings:

1. Forestlands are subject to tenure and title disputes often resulting in physical violence. The conflict between the public agencies and the custom and traditions of forest dwellers is hindering the forest management. The age-old un-enforced law having colonial bureaucracy has created uncertain legal status and a large number of litigation's and prosecutions. The forests are also being considered as protected areas in Bangladesh and already recognised by the Bangladesh government for taking special measures in those protected forest areas.
2. The history of forest management in Bangladesh is an integral part of British era, since 1947. After independence the first National forest Policy was formulated in 1979 and later an updated and revised policy was adopted in 1994. To achieve the target and objectives as stated in the policy the Govt. has also formulated a Forestry Sector Master plan (1995-2015) and Social forestry Rules'2000. The plan pointed



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out "Reforms in forest legislation" and "Institutional Reforms of forest department"-that are necessary for efficient and effective management of the country's forest resources.

3. Existing forest laws, customs and institutional practice are aggravating the situation as local people's policy and practices are largely ignored.

Significance for practical solutions:

1. The research has great value to bridging the gap of state's policy plan and historical inequality of local people's rights over their forest and forest land for better adaptation approaches.
 2. Intertwining both the state and people's policy could lead the society to better climate change adaptation and disaster risk reduction.
 3. Thus the result could examine the problems, limitations and opportunities globally in the legal regime by proffering new visions of participatory forestry towards ecosystem based community resilience.
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ABSSUB-594

SC 5.4 Building adaptation among fringe communities along the Atiwa Forest in an era of climate change

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Research question: Climate change is predicted to affect all facets of human life as well as natural systems. It is already having dramatic impact on the world's natural resources, and food security. Adaptation, one approach proposed to deal with the climate change challenge this century and beyond becomes important in developing countries where especially the rural poor are susceptible to weather events. Ghana like most developing countries would be most affected by the phenomenon, due to weak institutional arrangements and poverty which limits peoples' ability to adapt. The Rural Poor tends to be more vulnerable to climate change since on one part they lack choices and at the other their survival is directly depended on the natural environment. Adaptation programmes become preeminent in safeguarding the livelihoods of the rural communities in a developing country like Ghana. The forest ecosystem is among the world's most bio-diverse systems with different life forms constantly interacting to improve air and/or water quality for human wellbeing and also playing a crucial role in climate change adaptation and mitigation. The study set to find out key adaptation strategies communities are adopting to reduce vulnerability against adverse impacts of the continuous depletion of the Atiwa Range Forest Reserve and the long term climate change consequence.

Methodology: In carrying out the work, the mixed method of social science research approach was used; a total of 184 respondents were randomly surveyed from three communities along the range whilst 44 respondents were purposively selected for in-depth interviews and Focus Group Discussions. The results from the survey were analysed using the Chi-square test and binary logistic regression.

Findings: The major findings were that; respondents' perception on variable rainfall and a rising temperature in the area was corroborated by the scientific data obtained from the Ghana Meteorological Agency. Moreover, the locals perceived temperature increase and the lack of alternative livelihood programmes in their respective communities as major determinants of vulnerability which then affected their ability to adapt to



changing local and global climates.

Significance for practical solutions: The study concluded that, even though respondents were not consciously engaged in any adaptation measures, some of the ongoing practices especially farming practices were involuntary response to changing weather events. It was recommended that, in order to reduce vulnerability in the area and build the people's adaptive capacity, there should be deliberate effort by both the state and NGOs to introduce alternative livelihood programmes to give the locals choices.

ABSSUB-1214

SC 5.4 Ecosystem-based adaptation assessment, implementation and policy: lessons from multi-country projects

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Research question: Ecosystem-based adaptation (EbA) is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change. Despite the attention this approach has been receiving recently, several knowledge gaps still exist regarding how and where to implement it, how to measure and monitor its effectiveness and how to engage with policy makers to promote it in adaptation planning at various levels. We will present insights into those gaps, acquired through two multi-country projects conducted in contrasting socio-ecological contexts in Brazil, South Africa, Philippines, Costa Rica, Honduras and Guatemala. Research questions addressed included: a) How and where can EbA best be implemented? b) How can the effectiveness of EbA activities be realistically measured? and c) How can policy makers be best engaged to promote proven EbA successes in their legislation and decision making at a variety of levels?

Methodology: Activities were conducted to gather experience in completing climate change vulnerability assessments, in implementing EbA activities, in conducting economic analyses of EbA, and in engaging with policy and decision makers at all levels.

Findings: Through those projects, we have made strides towards improved understanding of vulnerability assessment, and the implementation, amplification and evaluation of EbA across diverse socio-ecological systems, which generated several insights. For example, the selection of the EbA interventions and the implementation sites should be ideally informed by vulnerability assessments. Vulnerability assessments conducted at the local level or related to specific sectors are the most valuable to guide EbA activities on the ground, whereas large scale vulnerability assessments better inform national decision-making processes. EbA interventions should preferably address a single climate change impact, or only a small number of impacts, to ensure that the intervention can be appropriately monitored. EbA interventions can also be implemented at the farm level to increase the resilience of farmers, and do not necessarily need to be only related to the conservation, management and restoration of natural habitats. Theory of change is a potential framework to inform monitoring and evaluation of EbA activities. Co- benefits provided by ecosystems should be taken into



account and monetized in the economic analysis of EbA.

Significance for practical solutions: These and other insights acquired through these projects can inform the implementation and amplification of EbA in other areas and research priorities, giving the lessons very broad relevance for EbA up scaling globally.

ABSSUB-713

SC 5.5 Trading-off ecosystem services with engineered and economic benefits to inform investment decisions

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Research question: Population and economic growth are fuelling demand for water, energy and food, thereby increasing pressure on water resource systems. Appropriate investments in mixed portfolios of built and natural infrastructure will aid sustainable growth and ecosystem maintenance. How should investments be selected and prioritised, given a deeply uncertain future, with many investment options and trade-offs? Can an approach be demonstrated for Kenya's Tana Basin?

Methodology: We simulate the water resources system to predict the impacts (positive and negative) of possible built and natural infrastructure investments. Impacts can be hydrological, ecological, engineering, economic, or social at local, regional or national scale. Stakeholders collaborate in validating and refining the model and defining performance metrics, which evaluate investments, relating various benefits to allocations, flow or storage levels. Benefits are expressed in mixed units and can, but need not, be monetised. The model is linked to a multi-criteria search algorithm that identifies (from billions of possible combinations and for multiple future scenarios) the portfolios of investments and operating rules which achieve the best 'bundles' of benefits, given conflicting demands for water. The search process is also able to define optimal scheduling of investments to meet projected demands for water or hydroelectricity, for example. The best benefit bundles are plotted as a range of options forming curves that map the trade-offs stakeholders and decision makers face in deciding how to share resources.

Findings: Trade-offs can be quantified to assess how investments in both built and natural infrastructure, including well-designed and operated combinations of new dams and upstream forest conservation, affect ecosystem services and economic benefits, and increase the resilience of the water resources system. Disparate stakeholders and decision makers value the opportunity to learn about each other's' plans and drivers for basin development and build their capacity for more integrated management and climate adaptation. Analysing trade-offs helps stakeholders and decision makers understand and engage with the synergies, diminishing returns on investment and tipping points beyond which the degradation of different benefits is unacceptable in their basin. An 'Action Learning' process can be used to move towards facilitating negotiation of investment decisions informed by the trade-offs revealed. Analysis of the political economy context helps identify opportunities to promote and apply the chosen portfolios of built and natural infrastructure.



Significance for practical solutions: A new approach to strategic and integrated river basin planning is demonstrated which better accounts for non-market ecosystem goods and services than would conventional investment screening tools. We feel it is potentially applicable to other river basins.

ABSSUB-1362

SC 5.5 The socio-economic vulnerability of coastal communities in Ghana to the impact of climate change

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Research question: What is the socio-economic vulnerability of coastal communities as well as the wetland habitats to the impact of climate change and what is their perception of persisting and emerging threats to their livelihood.

Methodology: This study sought to assess the socio-economic vulnerability of coastal communities in Ghana to the impacts of climate change taking the Anloga community as a case study. To do so, a case study design was adopted and multi-stage sampling involving purposive and simple random techniques was employed for the study. An integrated vulnerability assessment approach was used and vulnerability indicators of exposure, sensitivity and adaptive capacity were analysed using data collected from both primary and secondary sources.

Findings: Results from this study indicated that, the Anloga community is highly exposed to the impacts of climate change due to its geographical location. Coupled with the lack of economic opportunities, the community has a high dependency on farming and fishing as a source of livelihood and that, many households have no diversified source of income. The results also indicated that, the community has no adaptation plans in place to protect their economic sectors from the current and projected impacts of climate change hence increasing their vulnerability. Unpredictable seasonal patterns on the sea and land due to climate change together with anthropogenic pressures would therefore threaten the community's livelihoods and affect their food security.

Significance for practical solutions: This study is aimed at providing better understanding of the climate change vulnerability of the Anloga community and will contribute to policy formulation and adoption. The findings will be used also for developing local adaptation strategies or for mainstreaming climate change adaptation and mitigation into existing district or community plan. Drawing from the fact that developing countries are particularly vulnerable to climate change because of limited financial resources to deal with its impacts, the findings of this study will help decision makers, decision implementers, coastal resource managers and adaptation planners in the prioritization and in the efficient allocation of scarce resources to deal with the climate change challenge.



ABSSUB-805

SC 5.5 Economic values of ecosystem services benefits in pastoralist institutional arrangements in Kenya

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Research question: Northern Kenya Rangelands support a rapidly growing human population resulting from internal growth and immigration owing to its numerous and diverse goods and services. Communities in the rangelands are however grappling with poverty as they remain economically marginalized. This is largely a result of decision makers' lack of understanding of the value of the rangelands and how management of the rangelands can influence this value. An ecosystem service valuation approach is rapidly growing in the area of sustainable land use practices. This approach has not been commonly applied in the rangelands owing to the complex nature of the system and insufficient data. This paper compares economic values (household and communal revenues) of ecosystem services benefits across different pastoralists' institutional arrangements (elders only, Group Ranch committee and Community Conservancy boards) in the Northern Rangelands of Kenya.

Methodology: Three study sites namely Kinna Division, Makurian Group Ranch and West Gate Community Conservancy, representing three types of institutional arrangements were investigated. Data was collected using qualitative (key informants, focused group discussions) and quantitative (household survey) methods and analysed using Ms Access, Ms Excel and STATA software's.

Findings: Findings suggest that marginalized communities positively view modern hybrid institutional arrangements hinged on traditional mechanisms and that are consistently attracting strategic partnership, as a result of their capacity to offer risk management strategies.

Significance for practical solutions: The findings offer insight in implementation of the Kenya constitution 2010, the national land policy 2007 and Kenya Vision 2030.

ABSSUB-449

SC 5.5 Carbon stocks and biodiversity conservation on a small island: Pico (the Azores)

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Research question: With the growing awareness of climate change impacts, loss of carbon storage and sequestration has been increasingly analysed worldwide as one of the causing or amplifying factors. Solutions that contribute to decrease carbon releases and increase its sequestration, without compromising already threatened ecosystems, are required especially for small territories.



The focus of this study are the strategies for more resilient small islands, including spatial management to adapt to climate change while preserving biodiversity. The case study is the Azores archipelago (Portugal) and specifically the land use on Pico Island.

Methodology: Changes in carbon storage on Pico Island) were assessed between 1998 and 2013 using InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) Carbon Storage and Sequestration model. Changes in carbon stocks by land use change during that period, as well as its relationships with Pico Island protected areas and quality of natural habitats, were analysed.

Findings: Results showed higher values of carbon storage for bogs, cryptomeria, and endemic Macaronesian heaths. Major changes in total carbon stocks between 1998 and 2013 were the decrease in carbon in endemic Macaronesian heaths and the increase in carbon in cryptomeria, mainly due to changes in their total areas. Some conflicts between natural areas and invasive alien species were found, whose carbon values need to be carefully addressed.

Maximizing carbon storage and biodiversity without major trade-offs is possible but attention needs to be given to be sure not to lose value from one or the other variable. When higher carbon stock values are found for a certain land use category but with lower values for biodiversity or lower habitat quality, attention needs to be taken when deciding to increase these areas. On the other hand, when considering biodiversity conservation objectives, solutions that also contribute to increasing carbon stocks should be favoured. It was shown that compromises between land use / land cover changes might decrease trade-offs between conservation and human activities.

Significance for practical solutions: Results showed that it is possible to both enlarge carbon stock (economical value) and protect biodiversity (environmental value) simultaneously, through adapted and discussed management actions. This conclusion lends support to strategies that promote biodiversity conservation as a potential for climate change mitigation.

Considering similarities between small islands, and more specifically those of the Macaronesia Biogeographic Region (such as volcanic origin and remnant areas of native laurel forest areas), one can extrapolate the methods used in this study with minimum adaptation requirements. Also, proposed management guidelines can be applied to other Macaronesian islands and, with local adaptations, they can also be applied to other outermost regions.

ABSSUB-1165

SC 5.5 Governance analysis on natural resource management and ecosystem protection in Bangladesh

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Research question: Climate and its changing patterns constitute a dominant driver of natural systems. Proper management of the natural resource requires effective governance framework. A good governance system is essential for a sustainable natural resource and ecosystem management approach. Sustainable natural resource management and equitable governance approach is necessary to protect the world at a time of climate change, environmental degradation, increasing population and demand for finite resources. The mismanagement of natural resource undermines food production, habitats of natural species and the



availability of clean water, hence threatening human health and natural bio-diversity. This governance approach mainly focuses on the natural resource management and ecosystem protection related to climate change adaptation and migration. The goal of this analysis is therefore to find out whether the conservation of natural resource and restoration of natural system that supports life on earth in all its diversity are protected by existing Bangladeshi laws and policies or not ?

Methodology: To inquire the legal aspects on natural resource management and ecosystem protection to climate change adaptation and migration- available laws, acts, and policies in Bangladesh were studied based on a specific questionnaire. Questions were classified into three classes: directly relevant, indirectly relevant and uncertain relevance.

Findings: In the case of natural resource management-conservation of the protected areas, prohibition of hunting endangered species, protection of their habitats, dissemination of information such as environmental impact assessment, national report on the state of environment etc. are protected by relevant national laws, policies, and acts. Again, in case of ecosystem protection - restoration of ecological function, management of aquatic ecosystem in wetlands, canals, rivers, management of coastal and marine eco-system as integrated units covering both aquatic and terrestrial components, prevention the decrease in the quantity of harvested populations of animals and plants, sustainable use of biological diversity and its component into physical planning system are also protected by national legal system . However protection of non-target species , their habitats are not covered by the existing policies. Again In case of water resource management- institutional arrangements such as the establishment of the joint river basin commission and substantive norms for sharing the river basin in an equitable manner for transboundary river are also protected by national legal acts and treaties.

Significance for practical solutions: In the context of natural resource management and ecosystem protection, it is clear that adequate adaptation strategies and established governance approach must be developed which will surely promote a healthy ecosystem and protect the environment from being lopsided. The findings of the study will be helpful for the policy makers in Bangladesh and also other climate stress countries.

THEMES

6. DISASTER RISK REDUCTION





ABSSUB-953

SC 6.1 Measuring resilience - strengths, gaps and future directions

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Research question: What are the strengths and weaknesses of existing approaches to measure, evaluate and gauge resilience? What does this mean for future frameworks to measure resilience?

Methodology: The methodology entailed scouring academic database to arrive at a broad sample of literature. This was then refined using exclusion criterion and papers were retained that had an explicit focus on approaches for measuring, evaluating and gauging resilience from 7 areas of practice- disasters and DRR, climate change adaptation, food security, livelihoods, poverty, ecosystems and conflict. Forty-three papers/frameworks in total were selected for review. After consolidating this data set, the researchers then used an appraisal of foundational literature on resilience in socio-ecological systems to identify an analytical approach to examine each framework (systems thinking, issues around scales, trade-offs and resilience capacities). Following this, the 43 resilience measurement frameworks were analysed on the selected analytical parameters to identify strengths as well as the gaps that need to be filled by any future frameworks that may be developed.

Findings: Measuring the resilience of systems to shocks and stresses presents numerous challenges. The term itself has multiple meanings and is imbued with complex theoretical assumptions that are difficult to analyse and measure. This study deploys a robust analytical framework to review 43 resilience frameworks that can be used to measure, evaluate, test, and analyse resilience in diverse areas of development practice. It leads to the distillation of issues that future resilience measurement frameworks must engage with, these include-

- the need for more robust frameworks for measuring resilience at national levels
- a more rigorous engagement with systems thinking and complexity
- a deeper appreciation of the politics of resilience building that entails trade-offs (where resilience of one system can enhance the vulnerability of another)
- greater attention to exploring emerging concepts of transformation in measurement approaches.

Examples of the manner in which these issues can be practically included in future resilience measurement frameworks are also provided.

Significance for practical solutions: Accompanying the transition of resilience from an academic concept to one that is informing development programmes has been a strong emphasis on the development of frameworks aimed measuring, evaluating and gauging resilience.

This has resulted in a proliferation of resilience measurement frameworks and more are being developed every day. This study encourages resilience researchers to pause and reflect on the substantial body of resilience frameworks currently in existence to determine whether new frameworks are still needed.

More importantly, this study highlights the gaps and weaknesses of the current array of resilience measurement frameworks that are available to highlight the issues that any future frameworks must cover.



ABSSUB-766

SC 6.1 Capacity building for disaster risk management

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Research question: OPM has recently completed a two year research project with the University of East Anglia, investigating national and local capacity building for disaster risk management. The main research questions were:

- How is capacity for DRM generated most effectively at both national and local levels?
- What factors enable or constrain the building of national and local capacity for DRM?
- How and why does this vary across different environments?
- How is the international community currently approaching the task of building national and local capacities for DRM?
- How can we identify and measure improving capacity for DRM?

Methodology: The research involved fieldwork in six countries: Ethiopia, Pakistan, Myanmar, Philippines, Haiti and Mozambique. In addition the team conducted a global literature review and an online survey of DRM practitioners.

Findings: Many more findings were identified than can be elaborated here, but one key finding was that the international community is currently taking a piecemeal approach to DRM capacity building, typically implementing small, uncoordinated projects in low-income countries. Programmes tend to focus on preparedness and overlook building capacities for prevention, mitigation and especially recovery. Regional and local government are also generally overlooked, with more attention going to the national and community levels. Other problems include poor M&E, missing needs assessments, weak gender awareness, a lack of attention to long-term changes in risk or vulnerable groups, and very short timescales. On a positive note, programmes are showing good levels of ownership, participation, flexibility and relevance to the local context. The research produced a set of 'key principles for DRM capacity building' and corresponding evidence, as well as a theory of change for DRM capacity building.

Significance for practical solutions: The research has produced a number of outputs specifically for policymakers and practitioners. These include a checklist of key principles for effective DRM capacity building, an M&E framework and accompanying guidance notes and a matrix of recommendations.



ABSSUB-712

SC 6.1 The influence of livelihood assets to resilience household in flooding condition at rural Indonesia

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Research question: Research Question of this study was how the use of livelihood assets can influence farm household resilience in flooding condition rural Indonesia, especially at Rural West Java.

Methodology: This study combined quantitative approach using questioner method and qualitative approach using depth interview method. Factors that influence the resilience tested with linear regression analysis, using SPSS version 20.

Findings: This study divides the farm household into three stratifications. They are lower household, middle household, and upper household. Overall livelihood base built by farmer households is human capital and social capital. Floods demanding farmer households to other livelihood activities outside the agricultural sector. The non-farm livelihood activities require other skills to be possessed by the head of the family beside farming. Social capital is determined from the strength of the network owned by farmer households. Besides that, the familial relationships among the community is still high. In the analysis of the farmer household's income structure is known that the lower household's income structure is dominated by activities on farm and off farm. The most substantial contribution to the lower household income is the non-farm sector. This condition happened because on farm and off farm sector have been unable to provide sufficient household needs. Middle household dominated by non-farm sector, only a few households still depend on the on farm and off farm sector. Other findings that income from non-farm sector is higher than on farm and off farm sector. This is due to the agricultural sector only produce at harvest only. Upper household income is dominated by the on-farm and nonfarm sector. Based on SPSS trials, livelihood assets which affects the level of farmer household resilience is human capital, social capital, natural capital, and physical capital.

Significance for practical solutions: Floods are the external factors out of farmers controls. Thus, the policies should focus on efforts to minimise the impact of losses farmers from floods. Based on the results of the study in Rural Indonesia, farmer households in the flooded areas need to strengthen the non-farm sector because the revenue base in the flood region relies on the non-farm sector. Non-farm sector can only be strengthened by empowering the community because the greatest livelihood base is human capital. Community empowerment requires the cooperation of various stakeholders, include the community, governments, NGOs, and academia. Moreover, social capital needs to be maintained as a feature of rural Indonesia. The increasing of human capital and social capital will strengthen farmer household resilience during crisis conditions, that is floods.



ABSSUB-212

SC 6.1 Understanding adaptation and resilience in the national disaster resilience competition in the USA

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Research question: To what extent is resilience and adaptation subjectively conceptualized and objectively incorporated into plans by participating jurisdictions within the National Disaster Resilience Competition?

Methodology: This exploratory research utilizes a mixed-methodology based a combination of interviews, focus groups, and workshops, as well as a textual analysis of primary and secondary plans, documents, laws, codes and policy documents. A majority of the data collected occurred during the 2015 Rockefeller Foundation Resiliency Academies wherein subject matter experts were paired with participating jurisdictions to assist in plan development. These academies provided the researcher with access to multiple jurisdictions, as well as organising and planning documents for all of the jurisdictions, including those of the lead agency for the U.S. government.

Findings: While the research is still ongoing, the initial findings suggest that resilience and adaptation are not very well understood or conceptualized by the participating jurisdictions. The projects can be classified: (i) as sustainability projects recast in rhetorical terms as resilience; (ii) adaptation projects (mostly concerning retreat scenarios) that are incorrectly identified as resilient; or, (iii) conventional capital projects that serve risk mitigation ends but without the incorporation of climate science or adaptation planning to accommodate the known and unknown parameters associated with climate change. A working hypothesis which partially explains the disconnect between disaster risk management and resilience/adaptation is based on two observations. First, the organising framework is limited because:(i) it is oriented exclusively towards social resilience; and, (ii) it conflates analytical aspects of resilience and adaptation which result in undue confusion. Second, the institutional aspects of working within a short-term disaster response framework (laws, funding time horizons, benefit cost analysis, discount rates, etc..) conflict with the long-term implications of climate change.

Significance for practical solutions: This research has potential application for developing normative institutional processes which manage the friction between the short- and long-term goals of disaster management and climate change. While some conflicts may be unresolvable as a political outcome, there is much room for greater analytical rigor which makes useful distinctions between the conflicts and synergies of disaster and adaptation planning. In moving from theory to practice, this research highlights a critical public perspective across a variety of risks and scales.



ABSSUB-1438

SC 6.1 Improving the business case for resilience

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Research question: One of the major gaps holding back investment in resilience is that the business case doesn't capture the full benefits. Presenting work from the GFDRR-funded 'Triple Dividend of Resilience' project, this presentation will look at the economic benefits of investing in resilience that are not captured by traditional cost-benefit analyses and other investment planning tools.

Methodology: The paper is based on a review of 20 World Bank and other disaster risk management projects and interviews with stakeholders in finance ministries and other sectors in Jamaica, Mexico and the Philippines.

Findings: This paper suggests that the existing methods of appraising investment decisions fails to incentivise DRM because they undervalue the resulting benefit streams. Through the use of the triple dividend concept, we provide evidence of the wider benefits of investing resilience with the intention of improving awareness and stimulating the development of appraisal tools that can incorporate these factors and enhance future investments in DRM. The triple dividend concept adds to the weight of evidence behind the benefits of DRM. It extends beyond only the benefits that accrue through avoided losses if disaster strikes to encompass secondary and tertiary dividends that are not dependent on disaster events. Even the possibility of a future disaster has real impacts on present-day decisions and economic growth. High aversion to risk means that potentially profitable investments are not made, and opportunities are missed to improve welfare and development. Action to manage disaster risk can encourage forward-looking planning, long-term capital investment, and entrepreneurship. Individual investments in DRM, including profitable investments in productive capital, innovation and entrepreneurship, can also generate specific social, environment and economic benefits, even if a disaster does not happen for many years.

Significance for practical solutions: The triple dividend concept has significant implications for incentivising investment in disaster risk management.

ABSSUB-620

SC 6.2 Extreme events, informal sector vulnerability and private adaptation in coastal mega cities of Asia

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Research question: Extreme weather events lead to significant impacts with short-and long-term consequences for the affected urban areas. The informal sector comprising households and small businesses are affected the most with greater vulnerability and limited capacity to adapt. This empirical study has been



undertaken to measure the impacts of extreme precipitation events on the informal sector in three coastal megacities of Asia – Mumbai, Bangkok and Manila. The study analyses the uninsured losses suffered by them and identifies the private adaptation responses.

Methodology: The study uses primary data collected from a survey of households and small businesses to estimate uninsured losses due to an extreme flood event. A detailed characterization of the losses is undertaken, by disaggregating losses into monetary damage to property, physical capital, equipment and inventory as well as loss of income, investment and disruption of essential services. The survey also focuses on the adaptation measures undertaken by the private stakeholders. These measures are further characterized using the existing typologies to understand costs, benefits, cross-linkages with public adaptation and private provision of public adaptation goods.

Findings: The findings of the study indicate significant monetary losses suffered by the informal sector on account of extreme floods. There are damages to building structure, appliances, assets and equipment and loss of workdays, inventory, unavailability of services and health impacts. In the absence of insurance coverage and alternate compensation mechanism, the impacts represent significantly large out-of-pocket expenses. Therefore, there is a real danger of extreme events pushing people into poverty in future. The study has further identified and analysed the adaptation measures designed, financed and implemented by private stakeholders themselves. They undertake recurrent measures with recurrent costs, such as, cleaning the surrounding compound and disinfecting premises and structural measures like increasing height of the surrounding plot, reconstruction, elevating electrical meters, etc. The adaptation measures have been characterized using the existing typologies and we find new dimensions in the form of effectiveness, frequency and financing of the adaptation measures.

Significance for practical solutions: The study has significant policy implications for highlighting the vulnerability of informal sector to extreme events and bringing into focus the role of private stakeholders in adaptation. The study further highlights the need to have effective insurance mechanism to provide protection against adverse impacts. Further, the private stakeholders undertake collective adaptation efforts with limited resources and technical capability, which can be strengthened or taken up by state actors to have long-term effect on the coping capacity. Well-directed adaptation efforts with long-term effectiveness would help future development as well as poverty alleviation in these cities.

ABSSUB-1280

SC 6.2 Hurricane Sandy as a tipping point for climate adaptation and resiliency in New York City

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Research question: Hurricane Sandy brought tremendous damage to the New York City and took the lives of 43 New Yorkers. In the years since, there has been significant discussion regarding the implications of the storm and its impact. This paper addresses a key question – does the storm represent a tipping point and fundamental transformation in urban coastal resiliency policy for the city and the surrounding region if not for the U.S. more widely? The objective of the research is to evaluate how policy shifts take place in the emerging era of climate non-stationarity, and how climate change is altering the disaster risk reduction policy arena, generally, and urban coastal risk management strategies specifically.



Methodology: The research focuses on review of the latent and manifest content of policy statements and directives, and interviews with urban coastal resiliency stakeholders in the post Hurricane Sandy context. The methods are used to assess the conditions of policy transformation and define the levels and conditions of risk management change.

Findings: The findings define a complex and multifaceted policy environment following Hurricane Sandy. The policy responses to Hurricane Sandy were highly varied and differentiated. In some cases, the storm precipitated fundamental transformative adaptation, especially at the household level; while at larger scales the evidence of policy tipping points is much more limited and difficult to discern. In many cases, no fundamental shifts in policy occurred.

Significance for practical solutions: The results provide improved understanding of how extreme climate events in the era of climate change can provide catalyst for shifts in disaster risk reduction policy. The review of the chronology of adaptation post Hurricane Sandy at the varying scales of response provide insight into early warning signals of potential policy tipping points and how engaged stakeholders could facilitate transformative adaptation.

ABSSUB-349

SC 6.2 Ensemble flood risk assessment and adaptation strategies in Europe at 4°C global warming

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Research question: Adaptation against future floods is key component in disaster risk reduction in highly populated areas such as Europe, particularly in view of the potential intensification of the hydrological cycle due to climatic changes. Yet, very few research studies have tried to quantify the benefits at regional scales of implementing adaptation measures to reduce the future flood risk.

Methodology: In this work, ensemble projections of river streamflow based on seven EURO-CORDEX RCP 8.5 scenarios are combined with recent advances in European flood hazard and risk mapping to assess changes in flood risk in Europe for the current century. A number of novelties are presented that address issues pointed out in previous flood risk assessments at continental scale: 1) flood hazard maps are derived by a 2D hydraulic model rather than through simplified approaches; 2) the frequency of extreme peak discharges is assessed through a peak over threshold approach; 3) a new methodology is proposed to bias correct the impact of climate projections, which does not modify the atmospheric variables nor the energy balance; 4) the risk assessment is based on high resolution (100 m) estimates of flood hazard, exposure and on updated flood vulnerability information.

Findings: Under a 4°C global warming scenario, by the end of the century flood risk in Europe is projected to increase by an average 220% due to climate change. When coherent socio-economic development pathways are included, central estimates of population annually affected by floods range between 500,000 and 640,000 in 2050, and between 540,000 and 950,000 in 2080, as compared to 216,000 in the current climate. A larger range is foreseen in the annual flood damage, currently of 5.3 B€, which is projected to rise to 20 - 40 B€ in 2050 and 30 - 100 B€ in 2080, depending on the future economic growth.



Significance for practical solutions: Through a sensitivity analysis we evaluated the risk-reduction potential of four different adaptation options, including rising flood protection levels, increasing water retention capacity, relocating, and reducing the flood vulnerability. Model simulations show that keeping the current relative values of flood impact is possible, though it requires an immediate and coordinated action at country level involving a combination of different adaptation measures. Finally, pros and cons of the four adaptation measures are discussed to help prioritize their implementation.

ABSSUB-982

SC 6.2 European flood insurance market structures: present and future performance, and possible reforms

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Research question: Consistent and accurate information of the evolution of flood insurance penetration rates is unavailable. We model the insurance purchase decisions under current market structures (such as no government compensation scheme or the introduction of such a scheme) and possible reforms such as employing a greater degree of national solidarity or market influence. We additionally model the joint decision between buying insurance and employing household level flood risk reduction measures.

Methodology: We develop a game theoretic model of the decision process of insurers to offer insurance and at what price; and the joint decision process of households to buy insurance and/or to employ household level flood risk reduction measures. We develop different models describing demand under the following market structure: Compulsory solidarity (such as in France) where purchase and supply is mandated; Compulsory market where purchase is tied to mortgage conditions (such as in Hungary); Free market where markets are left to provide insurance with little government interference; and Government compensation, where governments provide compensation payments while insurance companies continue to provide insurance (such as in Germany). We apply the developed models to the European Union to model how the current market structures may evolve under a scenario of increasing flood risk and how they may perform under certain reform scenarios, such as the introduction of public private partnerships as compared to government compensation schemes.

Findings: We provide estimates of the following indicators for each of the 4 market structures across the European Union for the years 2015-2055:

- Flood insurance penetration rates
- The number of households employing a risk reduction measure
- The affordability of a flood insurance policy
- The degree to which government compensation reduces the purchase of flood insurance
- The potential stress placed on government budgets.

Significance for practical solutions: The findings of this model will have significance for practical solutions because it provides evidence for how certain market structure may increase the number of individuals with flood insurance as a coping measure; how different market structures may influence the affordability of insurance; which market structure may create the best insurance outcome, while promoting households to employ risk reduction measures. We provide evidence that may be a useful input into national or EU level discussions about how to reform flood insurance market structures to improve a society's ability to cope with flooding.



ABSSUB-278

SC 6.2 Ho Chi Minh City adaptation to increasing risk of coastal and fluvial flood

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Research question: Coastal megacities in southeast Asia are a hotspot of vulnerability to floods. In such contexts, the combination of fast socio-economic development and of the impacts of climate change on precipitation and sea level causes serious concerns about the present and future increased damage that flood can cause to people and assets. We present our work on Ho Chi Minh City, Vietnam, for which we estimate the present and future direct damage from river and coastal floods. Our aim is 1) to assess the relative weight of each future driver in determining the flood risk of Ho Chi Minh, and 2) to discern the efficiency of feasibility of a vast range of adaptation strategies.

Methodology: We use a model cascade that comprises the Saigon river basin and the urban network, plus the land-use-dependent damaging process. We simulate changes in discharge for five return periods, thus enabling the probabilistic calculation of the expected annual damage to the city, for a number of future scenarios of climate change, socio-economic growth, and land subsidence, for year 2050 and 2100. Central to our assessment is the implementation of a range of adaptation strategies, including dykes, elevation, building reservoirs, upstream management, flood-proofing, halting groundwater abstraction.

Findings: We report that damages significantly increase due to sea level rise along the coming century, strongly depending on the emission scenario. Adaptation measures vary greatly in their effectiveness in reducing flood risk, and we discuss which seem to be the most appropriate option to tackle risk increase given large uncertainties.

Significance for practical solutions: Our results provide an organised scientific basis of evidence for the future risk in Ho Chi Minh City, and for the effectiveness of a set of adaptation measures for risk reduction. This information is critical in the context of local adaptation decision-making in the face of large future uncertainties. Further, it provides a case study with general principles that could be transferred to other contexts.

ABSSUB-651

SC 6.3 Real options analysis in climate change adaptation decisions under uncertainty

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Research question: Climate change is a growing concern, leading to calls for actions to protect vulnerable individuals and societies. However, uncertainties about the future magnitude of climate change act as barriers to implement timely and appropriate adaptation. Although there are diverse ways to address



uncertainty issues in adaptation, uncertainty remains a barrier in the decision-making process. Real Options Analysis (ROA) is used to address uncertainty in financial sectors such as stocks, commodities or energy. This approach incorporates flexibility (i.e. waiting, future growth, etc.) into options under uncertainty. Such flexibility enables decision-makers to observe the future, learn and make more informed decisions. In this regard, ROA suggests that the benefits from flexibility in decision-making should be considered as valuable. The aim of the research is to develop and apply the method of ROA in the case of climate change adaptation. Then, we will assess the possibilities of this new approach to adaptation decisions.

Methodology: At first, climatic variables are modelled using a stochastic process (e.g. Brownian motion). According to the quantified climatic variables, changes in risk over a planning horizon are generated by Monte-Carlo simulation. Through this process, uncertainty from natural events can be transferred into changes in EAD (Expected Annual Damages) or EAB (Expected Annual Benefits) over time. An option with an optimal timing and option value was given as a result of ROA. This process is iterated to find more optimal option and timing with alternations to investment conditions. Lastly, the performance of the optimal option is examined under various climatic scenarios. Coastal flooding of the Solent, South England, was selected as a case study. This is the third most flood-affected area in the UK after London and Hull. In addition, sea level rise is raising extreme water levels and adaptation is needed.

Findings: Our research shows changes in optimal timing and option value for one intervention measure depending on investment and hydrological conditions and climate change uncertainty. In some cases, the option to wait might be more preferable than option to invest now or vice versa. This implies that an optimal investment rule in ROA is dependent on future uncertainty and current information. In addition, the real option including flexibility of time is shown to be robust and flexible to future climate.

Significance for practical solutions: This research can see the possibilities of ROA as one of decision-making tools, providing an optimal option and timing for future investment under uncertainty. This implies that preparedness - to have an option but wait - for climate change will enhance our adaptive capacity more than without any options, even though our society is under uncertainty of climate change.

ABSSUB-1181

SC 6.3 Flood-risk awareness and as a first step to a self-reliant community during evacuation

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Research question: If the Isle of Dordrecht would be threatened by a flood and the inhabitants needed to be evacuated, the majority is not expected to leave the area in time. The city of Dordrecht explores the level of support for other evacuation strategies, for example to stay on the upper floor of your own house (vertical evacuation), or to look for a shelter in the neighbourhood (sheltering). The local authorities require insight in the public perception about these strategies and how to influence this.

Methodology: A survey has been used to collect data from inhabitants. During the survey questionnaires were distributed among a representative group of 1739 residents. The total response rate was 36%. Analysis of the results generated information about the level of trust inhabitants have with regard to their own self-reliance



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and perspective for action, related to the level of support for local evacuation strategies. At the same time of the survey the city of Dordrecht organised a free exposition about the impact of a flood for inhabitants and first responders. Visitors also used the app 'OverstroomIk' to find out the maximum water level inside their house in case of a flood.

Findings: In general Dordrecht residents are flood-risk aware and tend to trust the authorities for warning them, and providing instructions on how to act. Feelings of fear for floods are strongly coupled with a person's perspective for actions. The majority of Dordrecht residents indicate that the vertical evacuation strategy fits with their own feeling of safety: to stay at home or to go to a shelter in the neighbourhood. About 75% of the responders indicate that they will follow the local evacuation strategy. They trust their health being sufficient to deal with threat or danger. Based on the results of the survey, people who already need help under daily circumstances (elderly in particular) and those who generally fear floods, feel less self-reliant. Support of the local evacuation strategy is strongly interrelated with the feeling of self-reliance. The survey showed that feelings of fear and discomfort encourage inhabitants to investigate their options and gather information about flood risks and different evacuation strategies. Visitors of the exposition indicated that the information actually changes the way they would act in case of a flood. This strengthened the research conclusion that receiving risk information makes them feel safer, and leads to acceptance of the local evacuation strategy.

Significance for practical solutions: Support for an evacuation strategy can be generated if residents are sufficiently aware of the flood risk. If local authorities want to enlarge the general trust in the local evacuation strategies, they should focus on risk acceptance and encourage self-reliance. Experiences from different countries (using new media, storytelling, nudging) might help to enrich risk communication in order to improve risk awareness, heading for a self-reliant community. This research has been funded by the Municipality of Dordrecht.

ABSSUB-1084

SC 6.3 Climatic change adaption amidst other environmental hazards

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Research question: It is suffice to constantly assess community vulnerability and capacities with regard to climatic change and build their resilience through adaptation efforts, complementing mitigation efforts aimed at reducing the rate and magnitude of climate change. This framework has shifted from Disaster management to a sustainable approach of Disaster risk Reduction. Disasters are associated with extreme weather events. Climate change directly interacts with the exposure to climatic extremes. The challenge in the context of adaptation is to move from the understanding that climate change is occurring to concrete measures that reduce existing vulnerabilities of human and ecological systems. The focus in this study is examine the effects and responses of flood risk imposed by storm water among the urban poor living in the highly vulnerable shanty neighbourhoods on the outskirts of Kampala city centre. It explores the underlying vulnerabilities of the two areas and the challenging problem of how to effectively shape human institutional responses to the risk of natural disasters with a special focus on floods.

Methodology: The social risk management and asset-based approaches on which the study is based provide a



conceptual framework for understanding the sequential links between risks; human exposure and sensitivity; the impacts of risky events; and risk management strategies.

Findings: The outcome of the study shows marked differences in the vulnerability factors and the management of flood related disasters in the two study areas. Furthermore, it was revealed that the indigenous coping mechanisms employed by the poor may become less effective as increasingly flimsy livelihood systems struggle to withstand disaster shocks.

Significance for practical solutions: Strategies to reduce vulnerability should be entrenched in vulnerability analysis and greater understanding of both household-level and universal-response options that are available to decrease the vulnerable exposure to climate risk.

ABSSUB-745

SC 6.3 Adapting social protection systems for Disaster Risk Reduction

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Research question: OPM is undertaking a large multi-country research study on how social protection systems can effectively be used in disaster situations. The research began in March 2015 and will be completed in March 2017. The study aims to strengthen the evidence base as to when and how social protection systems can better adapt in response to climate-related shocks in low-income countries and fragile and conflict-affected states, thus minimising the impact of disasters and reducing the need for separate humanitarian responses. There is much attention in social protection circles as to how existing, functional systems can be scaled up in disaster situations, but less attention paid to this issue in disaster risk circles, and less consideration of which and how DRM systems can be used to enhance effectiveness. The key question under investigation is 'Under what conditions can social protection systems be responsive to climate related disasters and deliver effective disaster response? A particular area of study will be on the use of DRM mechanisms, for example early warning systems, DRM committees and risk assessments, and how these can be linked more effectively to social protection systems.

Methodology: The research is based on a case study approach, with three in-depth and three lighter touch studies. The in-depth studies focus on Mali, Mozambique and Pakistan, and the lighter touch studies focus on Philippines, Lesotho and the Sahel region. In addition the team are undertaking a global literature review. In some countries, such as Pakistan, Kenya and the Philippines, significant progress has been made with using social protection systems in response to floods, drought and typhoons. However, other vulnerable areas, for example, the Sahel, have made less progress. The research aims to identify lessons learned and analyse how these can be applied in different contexts.

Findings: By the time of the conference in 2016 the research will be more than half way through. We will therefore not be able to present complete findings, but will have a range of preliminary findings and finalised outputs to share. We will share the findings of our global literature review on disaster responsive social protection systems, particularly highlighting enablers and barriers to effectiveness, and the typology we have developed of disaster ready social protection systems. We will have completed most of the fieldwork for the three in-depth country case studies and so will be able to present findings from Mali, Mozambique and Pakistan, and suggest some emerging global themes. We will also be able to share a finalised toolkit.



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Significance for practical solutions: The research has been designed to have an operational, participatory approach, and in each case study country workshops are being held to identify practical solutions and plan a way forward. One of the outputs of the research will be a toolkit, which is being tested in each case study country. Policy recommendations will be provided both at country and global levels.

ABSSUB-1027

SC 6.3 Tools for loss and damage decision making

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Research question: Loss and Damage (L&D) of climate change has emerged as a new pillar of the international climate change regime. As the political discourse on L&D is conducted within the UNFCCC, the implications for decision-makers remain somewhat unclear. In this paper we explore if and how decision makers can address the different policy objectives embedded in the L&D discourse and what challenges they face.

Methodology: Our analysis is based on the limited, but emerging literature on L&D as well as policy documents and case studies. We consider parallels and lessons learned from the climate adaptation field, with a particular emphasis on the use of risk assessment tools for L&D. We then expand our investigation beyond the policy-making field and consider the role of private sector decision-makers for design and delivery of L&D solutions. Against the backdrop of growing expectations that the business community will support the emerging L&D framework through knowledge, skills and resource, we reflect on the challenges that may arise.

Findings: We identify three broad policy goals embedded in the recent L&D discussion: creating awareness about the sensitivity of human and natural systems to climate change; developing risk reduction and risk management approaches to enhance adaptation, reduce vulnerability and build resilience; and informing compensation mechanisms. WE discuss implications and challenges arising for public and private decision makers. Our paper concludes with an outlook, indicating research needs and necessary practical steps for the UNFCCC process and beyond.

Significance for practical solutions: This paper forms part of a new initiative to bring together experts of L&D in order to support policy makers in their efforts to design and implement the UNFCCC's Warsaw Loss and Damage Mechanism (WIM). WIM was set up by climate negotiators at COP 19 for "dealing with climate-related effects, including residual impacts after adaptation." Since then, the WIM has been subject to very contentious debate. While some consider it the 3rd building block of negotiations under the UNFCCC, others see it merely as an attempt to establish liability, and suggest its remit would be better covered under negotiations dealing with climate adaptation. The exact focus and form of this mechanism is largely unclear and will see heavy debate over the coming years scheduled for developing proposals, which are foreseen to be presented at COP 22. Exploring implications for policy makers and the private sector can help to clarify expectations, challenges and prospects of this relatively new UNFCCC focus area.



ABSSUB-434

SC 6.4 Heat vulnerability index for London: an update

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Research question: How has heat vulnerability changed in Greater London, UK?

Climate change comes along with warming and more extreme weather. Heat waves and hot weather are a risk for human health, especially in urban areas, where the urban heat island effect, air pollution and a high population density increase the pressure. In 2009, a spatial heat vulnerability index (HVI) for London has been developed, applied, mapped in GIS using 2001 census data. The performance of the HVI had been tested using mortality, ambulance call and temperature data. Now, this index is updated with more recent census data from 2011. The resulting vulnerability patterns are compared with the previous HVI. The geographic scale chosen (lower layer super output areas) allows to characterise specific neighbourhoods. The challenges and limits of such indices and science policy interaction are also discussed.

Methodology: By reviewing risk factors for heat stress from the literature, suitable variables from census 2011 are selected. A Principal Component Analysis is run to combine these variables to a HVI and to map the updated HVI in GIS. A cluster analysis in GIS shows, where hot spots of vulnerability are located and the results of this updated HVI are compared with findings from the 2001 HVI. Further to the combined HVI, also the single components of the HVI are mapped to give indications on the type of vulnerability. Changes between 2001 and 2011 are identified.

Findings: The scientific evidence of risk factors for heat stress has increased. Several variables from 2011 census are suitable and an updated HVI for London is presented using PCA. Maps of heat vulnerability are shown: a combined HVI, the comparison 2001 to 2011 and zooms into specific areas (high risk, most changes, selected neighbourhoods). The changes in the riskscape compared to the 2001 HVI are described and discussed.

Significance for practical solutions: The updated HVI for London highlights, where action to protect vulnerable people from heat stress should be targeted now. The components of vulnerability indicate, if a focus on physical measures to reduce heat or on social action to increase resilience is indicated. The spatial variability of the HVI raises questions about the sustainability of targeted measures and responses.

ABSSUB-1352

SC 6.4 Development of heat wave health plan in South Asian plains

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Research question: Heat wave is emerging as a new threat in South Asian plains across Indus and Gangetic regions. Climate Change and urbanisation are aggravating urban heat island effect resulting in death toll in the form of heat strokes, vector-borne diseases and other public health issues. LEAD Pakistan and Climate and Development Knowledge Network (CDKN) developed a heat health management plan for the city of



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Ahmedabad in India which dramatically reduced the number of deaths in the city in the face of severe heat wave in May-June 2015 causing more than 3,000 human casualties. The port city of Karachi also saw the worst heatwave in its history in June this year, resulting in more than 1,300 deaths. LEAD is working with the Urban Unit and Karachi municipality to develop a similar plan for the city. The media reports mostly attributed these disasters to peripheral governance issues such as electricity failures. However, the British medical journal went as far as calling it a public health emergency and attributed the trend to the global urbanisation [1]. The study evaluates how the implementation of heat health management plan develops local adaptation capacity against heatwaves and other climate related disasters and health issues.

[1] The Lancet Commission on Health and Climate Change (2015). Health and climate change: policy responses to protect public health. The Lancet, UK.

Methodology: Case Study Method will be used.

Findings: The study finds that there is a need to accurately quantify the avoided burden of disease and enhanced productivity. It also yields that tackling climate change and investments in adaptive capacity of the communities could be the greatest global health opportunity. The study also elaborates how the use of technology and the leverage of political support can enhance the disaster preparations. It highlights the need for increased investment in monitoring and surveillance of diseases and epidemics for a better understanding of adaptation needs. Finally, it urges upon governments and international development agencies to scale up financing in resilient public health systems.

Significance for practical solutions: The present study collects evidence for the consumption of the media, local policy makers, and public health officials and international health organisations for effective media reporting, public awareness, holistic disaster management plans and local adaptation actions.

ABSSUB-615

SC 6.4 Application of ClimAdaPT: local to Vila Franca do Campo Municipality (Azores, Portugal)

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Research question: Vila Franca do Campo (VFC) is a municipality in the Azores archipelago, in the North Atlantic, a Portuguese Autonomous Region. It has joined de ClimAdaPT.Local project with the main goal of establishing municipal strategies for climate change adaptation (MSCCA) and their integration on the local planning instruments. That would allow to local communities a higher capacity to respond to climate change. The methodology was adapted to the Portuguese reality from the model developed by the UK Climate Impacts Programme (UKCIP) that tries to answer two main questions: (1) what are the climate risks that might affect the decisions?; and (2) what adaptation are needed and when to implement them?

Methodology: To answer those questions several steps were established: vulnerabilities identification (present and future); adaptation options identification and assessment; integration of adaptation options into municipal planning instruments; and monitoring model for MSCCA.

Findings: VFC is currently more vulnerable to risks associated to excessive precipitation causing floods and landslides. Based on the climate projections for middle and long term, VFC will be even more exposed to these risks and also the increase of storms and tornadoes.



As a consequence, the expected direct negative impacts are related to cutting communication routes, loss of properties, degradation of drainage systems, loss of soil, agricultural damages, reduced infiltration capacity and water retention on soil. The negative indirect impacts will be the change of communities' lifestyle, social and economical conditions, landscape degradation and threats to biodiversity.

Significance for practical solutions: Although all these negative impacts it is possible to identify some opportunities that need to be explored in the MSCCA: artificial hydric reserves for agriculture, hydroelectric power generation, arable soil enrichment, renewable energy production, aquatic sports, better local fruit and vegetables production and introduction of new production species and tourism increasing numbers. Based on these negative and positive impacts, VFC identified a panel of prioritized and ranked adaptation measures to implement the MSCCA. As a final challenge, VFC defined ways to integrate those adaption measures into local planning instruments (such as monitoring of embankments and restructuring of drainage networks for rainwater in the short term, and aquaculture in the long term), in order to absorb current and future vulnerabilities specialization and weighting of adaptation alternatives depending on their potential impacts and adaptation costs. This process is under approval by VFC's municipal decision makers.

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SC 6.4 Cost-effectiveness of adaptation strategies to increase the resiliency of power distribution poles

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Research question: The Department of Energy reported that the United States (U.S.) power grid (the generation, transmission, and distribution of electrical power) will become increasingly susceptible to weather-related damage as the global climate changes. In 2011, Hurricane Irene left 6.5 million customers without power along the east coast of the U.S. Hurricane Katrina (2005) destroyed 72,000 power distribution poles, leaving 2.6 million customers without power. Several studies suggest that hurricane intensity will increase as sea surface temperatures increase as a result of the changing global climate. As hurricane intensity may increase, it can be expected that the number of hurricane related power outages will increase causing even higher damage costs. Therefore, it becomes crucial to explore climatic adaptation measures that may increase the resiliency of the power system.

Methodology: Within the power system, it is the distribution system (poles and lines) that is most vulnerable to hurricane damage; distribution pole failure accounts for approximately 90% of outages during hurricanes. This paper proposes climatic adaptation strategies for distribution poles. The adaptation measures are investigated under an potential increase in wind speed of 5-10% over 100 years, including modifications of the vulnerability model to help account for the effects of aging (deterioration) and other time-dependent changes not well captured by existing vulnerability models. The evaluation of the economic viability of the adaptation strategies is conducted with a Life-Cycle Cost (LCC) analysis that assesses the cost-effectiveness of adaptation on an annual basis.

Findings: The purpose of this paper is to explore the cost-effectiveness of various adaptation strategies for timber distribution poles that take into account the potential effects of climate change. The purpose of the study is not to examine whether there is direct relationship between climate change and change patterns of



wind hazard, nor to endorse any specific scenario of climate change (or lack thereof). The focus is to investigate the adaptation strategies that are cost-effective regardless whether or not hurricane hazard patterns are altered by a changing climate.

Significance for practical solutions: Findings of this paper will provide a useful tool for decision-makers in conveying resource allotment decisions to constituents.

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SC 6.4 Managing rainfall risks in agriculture: a case study on index-based micro-insurance in Senegal

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Research question: This paper seeks to answer how different modes of intermediaries' involvement in index-based micro-insurance distribution among smallholder farmers in Senegal influence the levels and patterns of insurance adoption. In this context, index-based agricultural micro-insurance is conceptualized as an innovative strategy for vulnerable farmers to enhance the management of rainfall deficit risks and thus to contribute to livelihood resilience. Insurance as a disaster risk reduction component is regarded as a supplement to climate change adaptation measures in rural areas that are characterised by rain-fed agriculture.

Methodology: A sequential mixed-methods approach was used to collect and analyse original field research data in the Kaolack and Tambacounda regions in Senegal between July and September 2015. This entailed a first stage of key informant interviews with relevant stakeholders in order to capture the general functioning of index-based micro-insurance in Senegal. Subsequently, a survey of 135 insured and non-insured farmers in 10 villages was conducted. Based on findings from the survey, the third stage consisted of five focus groups with insured and non-insured farmers in order to generate in-depth information on the specific role of intermediaries in index-based micro-insurance provision.

Findings: Results indicate differing distribution modes between the two regions in the sample along three dimensions. Firstly, the reliance on pre-existing organisational cooperative structures versus the creation of new structures, secondly the openness of the distribution systems to producers on a broad scale, and thirdly insurance purchase as an obligation versus insurance purchase as an option for producers. These diverse systems result in differing ratios and patterns of insurance adoption. In Kaolack, the overall level of adoption is limited, because cooperative members have exclusive access to the product. In addition, this mechanism creates a pattern of exclusion of mainly women, poor farmers, and small-scale farmers due to cooperatives' access restrictions. In Tambacounda, overall adoption rates are higher and insurance subscribers are generally more diverse in demographic and socio-economic terms. This finding is attributed to a high level of information provision, the availability of insurance for work instead of cash, and the involvement of intermediaries accessible to all producers.

Significance for practical solutions: Results of this research contribute to practical solutions for disaster risk reduction in rural economies by indicating what kind of systems for insurance provision increase the rates of adoption and thus their large-scale outreach and possible impact on livelihood resilience. They further draw



attention to the inclusion and exclusion of vulnerable subgroups of producers in index-based insurance as a risk management strategy. Finally, findings imply differences in the sustainability and scalability of distribution systems based on their specific characteristics and interrelationships.

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SC 6.5 Catalysing synergies between climate change adaptation and disaster risk reduction in agriculture

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Research question: How can the agriculture sector promote synergies in reducing risk and adapting to climate change? The agriculture sector is highly vulnerable to changing climate patterns and extreme weather events, absorbing almost 22 % of all loss and damage caused by climate-induced hazards in the past decade in developing countries. Investments in resilience are needed to prevent, mitigate and anticipate the adverse impacts of such climate-related natural hazards. Through governance structures and outreach to the most vulnerable populations, the agriculture sector holds a strong potential in integrating Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) strategies for consolidated action on the ground. While the conceptual synergies between CCA and DRR are well understood, more practical approaches for its operationalization are needed.

Methodology: Based on in-depth policy analyses, consultation with national stakeholders and lessons learnt from recent projects, this presentation will showcase through two concrete country case examples how the agriculture sector and its stakeholders can catalyse CCA and DRR linkages. Therein, the focus shall be, among others, on institutional and policy levels, the linking of climate risk and early warning systems and on sustainable farming practices which can serve both DRR and long-term CCA. The challenges of upscaling and how CCA approaches can help catalyse more sustainable recovery measures will be addressed.

Findings: Ultimately, the analysis aims to carve out drivers for success in integrating DRR and CCA effectively in agriculture development and provide recommendations, how the sector can contribute in bridging related goals of the three main post-2015 frameworks, namely: the Sustainable Development Goals (SDG); the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR); and the emerging Universal Climate Change Agreement expected at 21st Conference of the Parties under the United Nations Framework Convention on Climate Change.

Significance for practical solutions: Practical solutions will be showcased through two specific country examples.



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SC 6.5 Livelihood adaptation to long term exposure to volcanic ash at Volcan Tungurahua, Ecuador

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Research question: Volcanic hazards may be brief and episodic in their violent phases, but the long duration of high-risk periods that characterise many eruptions have complex and chronic patterns of social, economic and political impact. Like many hazards they also have long-term implications for recovery but response to the hazard may also entail processes of adaptation. By studying the case of agricultural communities living in the slopes of the volcano, this research aims at examining how knowledge and experience gained through long term exposure to volcanic ash has allowed people to adapt and transform their livelihoods.

Methodology: This presentation is based on information gathered during field research in the populated areas surrounding the Volcán Tungurahua between November 2013 and March 2014. It analyses data gathered at the household level in urban and rural areas located in the two provinces influenced by the volcano, Tungurahua and Chimborazo. It is based on qualitative and quantitative research that included interviews to 67 local residents across 20 different locations and a large-scale household survey (411 households) complemented with observations during the 4-month period of field research spent in the area.

Findings: Since the reactivation of Volcán Tungurahua in 1999, local farmers have gained significant knowledge about ash impacts on crops and animals. Through experience and long-term exposure to volcanic hazards, they have been able to experiment and identify the crops that are able to resist ash fall. This knowledge includes identifying the effect of different types of ash (grain size and colour) on different crops. For instance there has been a shift from potato farming to more ash resistant crops such as onions. Additionally, many farmers are diversifying the crops they plant and spreading the planting season as a way to lower the risk of losing all the harvest. In terms of livestock, farmers have developed a range of measures to protect their animals such as special provision of feed. Additionally, animals are sold quicker to prevent illness development which lowers their market price.

Significance for practical solutions: The knowledge developed by farmers in Tungurahua is showing clear processes of adaptation where farmers have developed responses and learning that allows them to reduce vulnerability. Put in a different way, the ability of people to cope with long term exposure to volcanic ash is showing that through trial and error and sharing of information between them, local farmers have been able to develop adaptation measures as a result of their own initiative. Equally relevant is the fact that this knowledge can be useful to other populations exposed to volcanic hazards elsewhere in the world, particularly in temperate climates where similar crops are harvested and animals are reared. There is also potential to draw lessons from the experiences of people exposed to volcanic hazards to inform our understanding of adaptation to a range of climatic and non-climatic hazards.



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SC 6.5 Disaster risk reduction efforts and factors affecting flood disaster management

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Research question: What factors affect flood disaster management in Katakwi district-olupe and Ngariam Camps?

Methodology: The study focused on 238 randomly selected internally displaced camp residents. Key informant interviews were conducted and data qualitatively analysed to assess issues that impeded successful mitigation of flood disasters.

Findings: Continued degradation of wetlands for crop cultivation and cattle over grazing were partly responsible for increased flooding during rainy seasons and drought during dry seasons. The absence of accessible micro-finance credit schemes to support recovery efforts of the communities' drastically undermined measures to reduce the impact of flood disasters. The district was reported to have lacked contingency plans to show the risks and likelihood of related disasters occurring with potential effects at the community level hence impeding disaster management and preparedness. Both the government of Uganda and the local government of Katakwi district had not practically earmarked emergency funds for disaster response. The affected communities had no storage facilities for emergency relief items like medicine and food. The idea of having community level food stores and granaries died out and this amplified the flood disaster with famine making disaster management difficult. The poor nature of the community's temporary mud bricks and wattle roofed huts exacerbated the impact of the floods since many huts were just washed down prompting more relief items like tents straining the relief efforts.

Significance for practical solutions: Gross awareness creation at the community level and alternative means of livelihood that do not constrain non-renewable resources have to be persistently addressed to mitigate against natural disasters in the district.

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SC 6.5 GO-NGO collaboration for disaster risk reduction in India: a SWOT analysis

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Research question: Effective and meaningful collaboration between the two stakeholders: Government and Non-governmental Organisations (NGOs) is imperative to attain the goals of Disaster Risk Reduction (DRR). Literature documents GO-NGO partnership is a harmonious and constructive approach with mutual respect and recognition based on four aspects such as co-operation, 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 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



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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 Organisations in a holistic and proactive manner. However, the study is an attempt to identify the Government and Non-governmental Organisational relationship in 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 like i) how far the existing GO-NGO collaboration is effective in managing disasters, ii) what are the strengths, weaknesses (internal factors), opportunities and threats (external factors) affecting to achieve the policy-goals of DRR, iii) what are the strategies or methods needed for effective GO-NGO collaboration?

Methodology: In this paper, the study was carried out in Balasore and Kendrapara districts of Odisha, India which are more prone to disasters like floods. Respondents from both Government Organisations and NGOs engaged in disaster management directly or indirectly were interviewed in order to have broader views and opinions on policy matters, problems 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.

Findings: 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 because of more control and authority over NGOs. There is irregularity of interaction between Government officials and NGOs which makes the collaboration weak.

Significance for practical solutions: The structural collaboration can create opportunities for more holistic risk and vulnerability management and long-term resilience building. The efficiency and capacity of disaster management strategies can be improved by the sharing of information and knowledge. It is recommended that mutual respect, trust, transparency and accountability should be present between both the stakeholders.

ABSSUB-1367

SC 6.5 Preparedness is overrated: community responses in (perceived) low probability contexts

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Research question: For any flood risk manager the 'safety paradox' has to be a familiar concept: low probability leads to a sense of safety, which leads to more investments in the area, which leads to higher potential consequences: keeping the aggregated risk (probability*consequences) at the same level. Therefore, it is important to mitigate potential consequences apart from probability.

However, when the (perceived) probability is so low that there is no recognizable trend for society to adapt to, addressing the potential consequences will always be the lagging point on the agenda. Preparedness programmes fail because of lack of interest and urgency, policy makers are distracted by their day to day business and there's always a more urgent issue to spend the taxpayer's money on. The leading question in this study was how to address the social consequences of flooding in a context of (perceived) low probability

Methodology: Disruptions of everyday urban life, large or small, can be caused by a variety of (un)expected



things - of which flooding is only one possibility. Variability like this is typically addressed with resilience - and we used the concept of Community Resilience as the framework for this study. Drawing on face to face interviews, an extensive questionnaire and publicly available statistical data we explored the 'whole society response' to two recent urban flood events; the Brisbane Floods (AUS) in 2011 and the Dresden Floods (GE) in 2013. In Brisbane we studied how the societal impacts of the floods were counteracted by both authorities and the public; and in Dresden we were able to validate our findings

Findings: A large part of the reactions, both public as institutional, to these two urban flood events were not fuelled by preparedness or proper planning. Instead, more important success factors in counteracting social impacts like demographic changes in neighbourhoods and (non-)economic losses were dynamics like community action, flexibility and creativity from authorities, leadership, informal connections and a shared narrative. These proved to be the determining factors for the quality and speed of recovery in both cities. The resilience of the community in Brisbane was good, due to (i) the approachability of (local) authorities, (ii) a big group of 'secondary victims' and (iii) clear leadership. Similarly in Dresden large groups of 'unprepared', ad hoc organised citizens managed to work together with authorities in a way that was effective and speeded up recovery.

Significance for practical solutions: The concept of community resilience is better fitted than 'social adaptation' to deal with the potential consequences of an (im)probable flood. Community resilience is built on capacities and dynamics that are part of everyday life and which can be invested in pre-event to minimise social impact of urban flooding. Investing in these might even have beneficial trade-offs in other policy fields.

ABSSUB-1557

SC 6.6 An analysis of longer-term recovery following major disasters in the Asia-Pacific region: lessons from resilient development

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Research question: How can disaster loss and damage systems be improved so as to support more resilient development?

Methodology: The research activities are being conducted by doing critical analysis of five case studies representing a range of hazard types (flood, tropical cyclone, earthquake, and tsunami) and characterising a diverse quality of recovery. The case studies include the 2008 Cyclone Nargis (Myanmar), the 2011 Bangkok Floods (Thailand), the 2001 Mekong Delta Floods (Viet Nam and Cambodia) and the 2004 Indian Ocean Tsunami (Indonesia). A qualitative research approach is being used that consists of literature review and document analysis, case study research, interviews with key researchers and actors in each case study, and an expert synthesis workshop.

Findings: Specific research objectives include: the identification of disaster loss and damage 'systems, an evaluation of the performance of recovery efforts against stated formal objectives, and an identification of the greatest achievements and challenges in building disaster resilience over a 5-10 year time period. The project is currently underway (year 1 of a 3-year activity) and some results have been gathered from the Thailand, Cambodia and Viet Nam sites. In Thailand, many Small-Medium Enterprises (SMEs) were affected by the 2011 floods and our research have managed to identify the actions the SMEs took after the floods subsided to



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reduce their vulnerability to future floods. In addition, identification of the state's actions, at numerous scales, ranging from the local and provincial to then national, since the floods. Responses include building or heightening new flood infrastructure, land use plans, compensation schemes, and early warning systems. Analysis on how these actions have affected the vulnerability of SMEs to future floods has been conducted. In Cambodia, aspects of disaster management strategies and planning at the local and national level, in order to enhance understanding of loss and damage systems and to identify practices that help build resilience.

Significance for practical solutions: The project will generate insights that will improve our understanding of the types of transformations required in societies at risk from natural hazards and climate change impacts in order to become more resilient to such risks.

ABSSUB-1561

SC 6.6 Assessing the linkages between climate change adaptation, disaster risk reduction, and loss

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Research question: 1) What are the potential entry points and opportunities for linking CCA, DRR and L&D assessment?; (2) Who should be involved in carrying out CCA, DRR, L&D activities?; (3) At what level of governance (national, regional, local, or community) will the linkages between CCA, DRR and L&D be optimized?; (4) At what temporal scale (short-, medium, or long-term) should the CCA, DRR and L&D be implemented?; (5) How can these issues be effectively integrated in development plans, projects, programmes and policies?; (6) How can CCA, DRR and L&D initiatives be best monitored and evaluated to ensure effective implementation?

Methodology: (1) A workshop will be organised to discuss and identify priorities, issues and concerns; develop the framework of analysis per country; and identify relevant stakeholders; (2) Assessment and analysis - review of related literature, focus group discussions and key informant interviews will be conducted; (3) Synthesis of country findings - will identify emerging issues, gaps and opportunities in linking CCA, DRR and L&D; (4) Development of CCA, DRR and L&D framework - will serve as guide for country and regional implementation; (5) Science-Policy Forum - will recommend R&D and policy agenda; (6) Lecture Series, Publications and IEC materials (via online platforms, TV and print media) - will disseminate the outcomes of the information generated from the project.

Findings: The project is a two-year project and currently in its first year activity focusing on gathering all available background data and collecting insights and experiences from experts through interviews, surveys, focus group discussions, and workshops. Case studies conducted shows that there are issues and gaps in the loss and damage assessment system that can be addressed by tackling challenges on standardization, data needs, capacity building, partnership, and governance. Loss and damage information is essential and relevant in planning and development decisions, and can be used to improve climate change adaptation and disaster risk reduction strategies. The existing challenges in the integration of climate change adaptation and disaster risk strategies must be addressed to efficiently and fully utilize loss and damage information for the improvement of these strategies.



Significance for practical solutions: This project will try to understand, at the national and regional scale, the gaps and needs for assessing and addressing the economic, social, and environmental aspects of L&D related to risk from current climate variability and future climate change. The low-lying coastal cities of countries involved in the project suffer significant loss and damages from climate-related disaster events. Identifying the available tools, methods, approaches, data applications (geographic, sectoral, temporal) will improve DRR and CCA initiatives.

ABSSUB-1559

SC 6.6 Addressing non-economic losses and damages associated with climate change: Learning from recent past extreme climatic events for future planning

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Research question: The important questions in the context of the present study are: What needs to be valued?; Who decides?; and How to compensate especially for those losses and damages that have high social value but least market value; for e.g. loss of cultural heritage that has historical value and certain biodiversity and ecosystem services.

Methodology: The first and major part of the research constitutes the development of analytical framework for assessing the intangible and non-economic impacts of extreme climate events experienced in the South and East Asian countries. The non-economic and intangible impacts are identified, prioritized and measured in a participatory manner through implementing structured questionnaire surveys with Likert Scale, focused group discussions and associated quantitative analytical techniques. An expert consultation in the first year of the project is helping prioritize the pertinent technical, practice and policy issues. Quantifying non-economic losses and damages has been relatively well developed for floods (Green and Penning-Rowsell, 2007; Lekuthai and Vongvisessomjai, 2001) than other natural disasters. To bridge this gap, the study will do a comparative analysis of the 'anxiety –productivity and income interrelationship approach' (Lekuthai and Vongvisessomjai, 2001) and damage indices approach (Petrucci, 2012) to evaluate the relevance to other natural disasters. In the second stage, the study team will qualitatively assess existing disaster risk reduction and climate change adaptation measures, with a focus on financial instruments such as risk insurance and compensation mechanisms, to assess the extent to which non-economic damages be considered in designing these responses. At this stage, the team will review and prepare guidelines for strengthening the adaptation and disaster risk reduction plans and policies at national and sub-national levels for addressing the non-economic damages.

Findings: Currently underway (this is year 1 of a 3 year project).

Significance for practical solutions: This research will help improve our understanding on the non-economic damages associated with the extreme climatic events (rapid and slow onset) and help introduce necessary changes in the risk reduction, transfer and pooling measures including risk insurance, compensation, microfinance etc. This will be transferred to the decision-making communities by developing policy mainstreaming guidelines addressing non-economic losses and damages targeting key policy makers and practitioners.



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SC 6.6 Capacity building for national and provincial stakeholders and remote communities on loss and damage

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Research question: How can Vietnam establish a comprehensive link between national agencies and local communities to develop and implement activities in response to immediate impacts of disasters while ensuring a sustainable foundation of knowledge and knowledge transfer to effectively reduce long-term impacts of climate change?

Methodology: The team started the activities by forming an expert group to review current policies and develop workshop and training plans and materials based on an in-depth assessment of current understanding and capacity in implementing DRR and CCA activities for both policy making and practice at ground levels. Three field trips were conducted by the team of central level to collect reliable data. After that, the team worked together forming new initiatives to optimize use of DRR and CCA resources. A workshop was convened to introduce the new initiatives and top leading experts in DRR and CCA provided comments and feedback for the team to revise those initiatives. At provincial level, the trainers of the training courses were selected based on the objectives of the courses and mainly consist of members of the group who developed the training materials. Trainees are to be educated the knowledge of loss and damage that related to climate change. Besides that, the training team will also consult trainees about effectiveness of those initiatives. For training courses performed at commune level, each training session comprises three main stages: (i) select trainers, (ii) prepare training contents and documents, and (iii) conduct parts of training. Trainers are mainly from the team members and additionally some invited in-field experts. Content for the training session is designed in an understandable way to normal people who have low levels of education. Graphic and visible illustrations such as pictures or diagrams are employed to design the training documents. These local trainings will take place in between national-level trainings and workshops implemented by NCCC to share training's findings and results among local and national stakeholders. Three final reports for three training sessions and one policy brief are provided as the key outcome of these training sessions.

Findings: The capacity building activities are not yet completed because this is a 2-year activity that has only concluded the first year. For this reason, full findings will be available at shared at the conference in Europe.

Significance for practical solutions: Provision of training tools for training workshops to develop the capacity of climate change focal points ministries, provinces and in remote communities to effectively address L&D and respond to climate change.



ABSSUB-1560

SC 6.6 Integrating Climate Change Adaptation (CCA), Disaster Risk Reduction (DRR) and loss and damage

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Research question: How can we improve the understanding of slow onset processes, especially its irreversible impacts that build over time with serious consequences on lives and livelihoods?

Methodology: (i) Meta-analysis of peer reviewed research identify the state of science (biophysical, social and economic and non-economic valuation) and policy; (ii) Participatory appraisals to identify and rank local level hazards and processes; (iii) Questionnaire surveys/interviews to supplement information for evaluating loss and damage; (iv) Comparative studies through local level pilots in selected countries to develop and test approaches; (v) Dialogues between researchers and policy makers of multi-disciplinary backgrounds on effective options to address and integrate DRR, CCA and L+D in development plans.

Findings: We are in the process of a 3-year activity (year one has been completed) that expects to Identify characteristics, priorities and emerging issues related to slow onset processes in low-lying coastal areas, floodplains and highlands of Southeast Asia that impacts the livelihood and well-being of the communities therein; assess limits to adaptation based on the "best available science" and propose risk based approaches that integrate climate change adaptation and disaster risk reduction; develop methodologies to evaluate prospective loss and damage (both economic and non-economic) associated with adverse and cascading impacts of climate change drawing on lessons from disaster risk management, and discerning natural and anthropogenic causes of climate change; and recommend policy and planning strategies to integrate climate change adaptation, disaster risk reduction and loss and damage in development plans in line with existing governance systems. In time for the PROVIA conference in Belgium in 2016, we expect that we will have significant findings that we can share with the adaptation community.

Significance for practical solutions: The findings as indicated in the previous paragraph are expected to provide information and advice for decision-making bodies on effective options to address and integrate DRR, CCA and L+D in development plans.



ABSSUB-1042

SC 6.7 Adaptation transitions in Lagos

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Research question: Lagos is a megacity with economic and political reach to the national level and beyond. It is also at risk from coastal and riverine flooding and heatwave risk. City risk management is marginalised in the rush for national economic growth. But how well oriented is this strategy for the emergent risks of the 21st Century. Are the administrative and organisational cultures and legislative regimes active in Lagos appropriate – are they inclusive and responsive? If not how might transitions in risk management and development be enabled through adaptation planning?

Methodology: The study is one of five megacities researched as part of a Belmont Forum project: Transformation and Resilience on the Urban Coast (TRUC). The project allows for consideration of the adaptation pathways made possible by contrasting science-policy relationships and governance regimes in London, New York, Lagos, Tokyo and Kolkata. Work in Lagos included original flood and heatwave risk maps at the city and ward level, household survey and semi-structured interviews with experts to examine adaptive capacity and pathways - and for transformation in development to support equitable adaptation.

Findings: There is only limited recognition of the interdependence of informal and formal settlement in the production of risk. Urban development shifts flood risk onto neighbouring sites. Risk managers see the future being increasingly constrained and their capacity to manage poverty driven risk reduced as power continues to be eroded from the local state and large private sector interests set the speed and trajectory for urban development. This is despite expectations for continued increase in the human resources and influence of science in Nigeria.

Significance for practical solutions: Policy makers were an intrinsic part of the study and the tensions identified are well recognised. Interestingly many scientists felt there was little transparency in the interaction between science and policy and the subsequent policy trajectory was removed from the majority of science providers in Lagos. Lagos stakeholders – especially the poor - have proven very able to adapt once threats are present and recognised, being able to build resilience in the face of future risk or being able to accommodate emergent risk is less obviously an area of strength.



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SC 6.7 Adaptation transitions in Kolkata

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Research question: Kolkata is a megacity with economic and political reach to the national level in India. It is also situated in the low-lying lands of the Indian coastal plain and exposed to coastal storms, rainfall flooding and waterlogging. The city is characterised by extremes of inequality and the interdependence of informal and formal economies, workers and land-use. The paper is interested in the extent to which existing approaches that dominate risk management and development relationships in the city might be amenable to change in the light of anticipated environmental and social change up to mid-21st Century.

Methodology: The study is one of five megacities researched as part of a Belmont Forum project: Transformation and Resilience on the Urban Coast (TRUC). The project allows for consideration of the adaptation pathways made possible by contrasting science-policy relationships and governance regimes in London, New York, Lagos, Tokyo and Kolkata. Work in Kolkata included original flood and heatwave risk maps at the city and ward level, semi-structured interviews with experts to examine adaptive capacity and pathways and a household survey to draw out interaction between city level and household level expectations of rights and responsibilities for adaptation - and for transformation in development to support equitable adaptation.

Findings: There is only limited recognition of the interdependence of informal and formal settlement in the production of risk. Urban development softs flood risk onto neighbouring sites. there is also limited awareness of heatwave risk. Risk managers see the future being increasingly constrained and their capacity to manage poverty driven risk reduced as power continues to be eroded from the local state and large private sector interests set the speed and trajectory for urban development.

Significance for practical solutions: There is only limited recognition of the interdependence of informal and formal settlement in the production of risk. Urban development shifts flood risk onto neighbouring sites. There is also limited awareness of heatwave risk. Risk managers see the future being increasingly constrained and their capacity to manage poverty driven risk reduced as power continues to be eroded from the local state and large private sector interests set the speed and trajectory for urban development.



ABSSUB-1038

SC 6.7 Adaptation Transitions in Tokyo

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Research question: Tokyo is a megacity with economic and political reach to the national level and beyond. It is also at risk from earthquake, flooding and heatwave risk. City risk management has been rightly dominated by earthquake risk management. But how well is the city positioned to adapt to increased flood and heatwave risk? In what ways do the cultural and administrative structures in Tokyo and Japan enable and constrain adaptation and scope for working at development as a root cause of risk?

Methodology: The study is one of five megacities researched as part of a Belmont Forum project: Transformation and Resilience on the Urban Coast (TRUC). The project allows for consideration of the adaptation pathways made possible by contrasting science-policy relationships and governance regimes in London, New York, Lagos, Tokyo and Kolkata. Work in Tokyo included original flood and heatwave risk maps at the city and ward level and semi-structured interviews with experts to examine adaptive capacity and pathways - and for transformation in development to support equitable adaptation.

Findings: Tokyo's risk governance regime has been built to provide stability and to some extent resilience in the face of earthquake risk. Even considering emergent risk is difficult in this context and exacerbated by a science-policy context where recognised experts form a small cabal close to government. This makes any change in direction difficult. A trade-off for high quality and trusted science relationships during periods when hazard is known.

Significance for practical solutions: Policy makers were an intrinsic part of the study and the tensions identified are well recognised. Interestingly many scientists felt there was little transparency in the interaction between science and policy and the subsequent policy trajectory was removed from the majority of science providers in Tokyo. Tokyo has proven very able to adapt once threats are present and recognised, being able to build resilience in the face of future risk or being able to accommodate emergent risk is less obviously an area of strength.



ABSSUB-1040

SC 6.7 Risk management regimes transitions in megacities

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Research question: The specific goal of the paper is to develop and apply a framework that illustrates adaptation pathways in urban coastal settings facing the threat of extreme climate events. The framework incorporates a set of different risk management regimes, the conditions of transitions between them, and the associated social-ecological and temporal dimensions of these transitions. The framework is illustrated through case examples of post Hurricane Sandy New York City.

Methodology: The case study of New York City provides a forum to implement the framework and examine the issues of risk management regimes, transitions, and opportunities for enhanced sustainability. Substantial amounts of empirical data and information about local conditions of risk and vulnerability, disaster risk reduction policy and management, and trajectories of economic development are required to operationalize the framework for each selected city.

Findings: To help characterise the degree to which risk management is able to take on the potentially far reaching implications of responsibility for sustainable development goals we outline four policy states: collapse (no planning), resistance (planning for stability), resilience (flexible planning) and transformation (planning for fundamental change). Our contention is that given the distance between current urbanisation trajectories and the goals of sustainable development within risk management fundamental changes are likely to be necessary.

Significance for practical solutions: The work here does not seek to examine in detail sustainable development practices, but rather takes this as a broad policy aspiration and seeks to identify those opportunities that exist within the remit of disaster risk management and climate change adaptation planning to contribute towards this goal. The paper takes the position that transformation can occur within the contexts of multi-layered systems, formal and informal politics, and structural limits on local action and agency of individuals and specific organisations. The framework can be applied with a minimum of knowledge and analytical material but the more extensive the foundation, the greater the validity and deeper the understanding.



ABSSUB-1045

SC 6.7 Adaptation transitions in London

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Research question: London is a megacity with economic and political reach to the national level and beyond. It is also at risk from coastal and riverine flooding and heatwave. Adaptation is framed within a discourse of resilience, with resilience planning vulnerable to shifts in political values. Adaptation planning in London is also distributed between local authority, city and national agencies further complicating vision, capacity and scope for action. The paper asks how fit London's regime is to consider and enable transitions to face emerging risk – especially around heatwave events in the mid 21st Century.

Methodology: The study is one of five megacities researched as part of a Belmont Forum project: Transformation and Resilience on the Urban Coast (TRUC). The project allows for consideration of the adaptation pathways made possible by contrasting science-policy relationships and governance regimes in London, New York, Lagos, Tokyo and Kolkata. Work in London included original flood and heatwave risk maps at the city and ward level, scenario workshops and semi-structured interviews with experts to examine adaptive capacity and pathways - and for transformation in development to support equitable adaptation.

Findings: London's risk governance regime has been built to provide stability and to some extent resilience in the face of flood risk. Heatwave risk management has become medicalised. This makes sense, the national health service provides an accountable and directed line for management. It does however lead to a responsive adaptation strategy. Prevention requires working with social services and carers for vulnerable groups such as the elderly. In a city with a dynamic and growing elderly population this is not easy. Organisational and cultural constraints to this process of transition are discussed. Significance for practical solutions: Policy makers were an intrinsic part of the study and the tensions identified are well recognised. Interestingly many scientists felt there was little transparency in the interaction between science and policy and the subsequent policy trajectory was removed from the majority of science providers in London. London stakeholders have proven able to adapt once threats are present and recognised, being able to build resilience in the face of future risk or being able to accommodate emergent risk in the long-term is less obviously an area of strength.



ABSSUB-1270

SC 6.7 Future in the making: participatory risk and transformation scenarios in coastal megacities

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Research question: The presentation asks how scenarios for risk pathways in highly vulnerable coastal megacities can be developed. In particular, it focuses on the role of local urban stakeholders in the field of administration, planning and risk management in such scenario development. The presentation therefore presents findings from participatory scenario workshops in four coastal megacities within the framework of the BELMONT-Forum TRUC project (Lagos, Kolkata, London, New York City). It analyses the methodological, contextual and practical lessons resulting from the scenario development implemented in these workshops.

Methodology: The paper presents an innovative method developed within the TRUC project to generate risk scenarios for coastal megacities in a participatory manner, i.e. in workshops with 10-15 key stakeholders per city from planning and risk management agencies as well as civil society groups. A key goal of this method is to relate potential risk and adaptation pathways to overall urban development trends in the respect city. The method collects key drivers of risk and uses them to populate a four-dimensional scenario space. The scenarios subsequently are used as storylines for quantitative modelling.

Findings: The research allowed to (1) identify the main drivers of risk and urban transition in the four case study cities as well as to (2) develop context specific and practically relevant scenarios of risk and development pathways in the four cities. Key factors included topics such as demographic changes, shifts in risk management paradigms or changes in the responsibility for adaptation between state and non-state sectors. While context-specific scenarios could be developed to inform risk management in each of the cities, a number of surprising themes emerged that cut across the very different case study cities.

Significance for practical solutions: Current climate risk assessments used for planning purposes typically suffer from a significant weakness: they combine future projections of hazard changes (e.g. sea level rise) with current patterns of socio-economic vulnerabilities. The method and findings of this paper, however, helps to make the necessary next steps in risk management and to develop tools that enable scenarios in the domain of urban socio-economic vulnerability. This innovation is needed for achieving integrative risk scenarios that can inform adaptation decisions today and in future.



ABSSUB-1324

SC 6.7 Assessing future exposure and vulnerability in megacities to capture transitions and adaptation

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Research question: Risk and vulnerability assessment methods in the context of climate change require next to climatic scenarios also scenarios about future exposure and vulnerability patterns in order to understand future adaptation needs and potential transitions towards resilience. While this conclusion represents an emerging consensus in the scientific community (IPCC 2014), it is still open on how such scenarios can be developed and applied particularly at the local level in terms of the data available and the storylines used. Based on research within the TRUC project indicators and semi-quantitative tools are presented that allow to estimate future scenarios for vulnerability and exposure in selected megacities, namely New York, Tokyo, London, Lagos and Kolkata.

Methodology: In terms of data and methodologies, new scenario data of Oxford Economics as well as data from the global modelling community (Shared-Socio-Economic Pathways) are examined in terms of their ability to inform local scenarios development and the identification of transitions in the future with regard to the vulnerability of people exposed. These expert driven approaches are complemented with semi-quantitative data from a household survey that illustrates judgements about future trends and transitions from individual households in Lagos. The mixed-method approach allows to compare different scenario approaches and data sources in order to better understand various perspectives about future conditions of exposure and vulnerability by people at risk and experts.

Findings: The findings provide important insights into the opportunity and limitations to assess future scenarios of exposure and vulnerability linked to natural hazards and climate change on the one hand and societal changes on the other. The results also allow to judge to what extent different global, national and local data sources provide a meaningful information about future conditions of exposure and vulnerability for adaptation planning and disaster risk reduction. Against the identified future changes of exposure and vulnerability concepts such as resilience versus collapse and adaptation as well as transformation will be critically revisited and discussed.

Significance for practical solutions: The paper and the findings are highly relevant for practical solutions and for decision making processes. The effectiveness and appropriateness of selected strategies in climate change adaptation and disaster risk reduction at the local scale depends not only on present conditions, but also on potential future scenarios about exposure and vulnerability of people at risk. Consequently, the results and the limitations identified provide significant information for institutions and policy makers concerned with disaster risk reduction and climate change adaptation. The study underscores - among other issues - that different people and experts view potential pathways of exposure and vulnerability in the future differently.

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ABSSUB-1120

SC 7.1 Barents region futures under different global socio-economic scenarios

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Research question: How might global developments influence local futures in the Barents region, and what differences exist within the region? We present a systematic methodology for how global socio-economic pathways can be utilised at the local level in a participatory setting for generating narratives about the future. We also present example narratives from a workshop series consisting of three workshops in the Barents region in which local and regional actors generated possible futures linked to a set of global scenarios in a time perspective of 30–50 years.

Methodology: The methodology employed utilises the ‘scenario matrix framework’ developed by the climate change research community. In our approach, the local futures narrative are based on linking local and regional “bottom-up” input with the global contexts are provided by Shared Socioeconomic Pathways (SSPs) of the matrix framework. Interactive workshops held in the Swedish, Russian, and Norwegian north generated the bottom-up input, where participants identified locally relevant drivers of change and discussed how they might play out in different future worlds as provided by the SSPs.

Findings: The results show that active engagement of local actors brings out dimension and issues that are usually not highlighted in scenarios that focus on larger scales. In addition to climate change and its impacts, the narratives generated from the workshops highlight both specific local concerns and how they link to developments at other scales. The issues include power over decision-making, sense of place, and social features that affect the capacity to shape the future and to adapt, such as entrepreneurship. Demography, including migration, also plays a central role in future challenges from a local perspective. Finally, global market dynamics, international cooperation and security are identified as a key factors which will play out differently at the local level under different global futures.

Significance for practical solutions: A key challenge for the impacts, adaptation and vulnerability (IAV) community is to enhance comparability between studies from different regions and from different sectors. The new scenario matrix framework is a promising starting point for doing this. The work presented here shows one way of utilising this framework and at the same time ensuring that knowledge and perspectives from local stakeholders are included. In our case, the workshop results show that participatory methods for co-producing future narratives are a powerful way to add nuance to discussions about Arctic futures. These can be used to explore the boundaries of Arctic futures, the “best and worst case” scenarios for local adaptation, and to test the robustness of certain decisions.



ABSSUB-532

SC 7.1 The construction of socioeconomic scenarios to guide adaptation in the Eurasian Arctic

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Research question: The future of the Eurasian Arctic (EA) is shaped by several drivers. Climate change and the sea ice retreat require adaptation by the current actors in the area. At the same time, these physical changes arouse more interest towards the area, possibly increasing the scale and quality of future human activities, and creating adaptation needs for the current and new actors. To anticipate the future changes under different sources of uncertainty, and to obtain an understanding of the possible near-term development and adaptation needs, particularly related to Weather and Marine Services (WMSs), our study has developed a set of generic socio-economic scenarios up to 2040 for the EA, and a set of sector-specific scenarios with a shorter time-frame with a focus on the role of Finland in the region's development.

Methodology: The scenarios were based on existing climate and socio-economic scenarios but the main input was obtained through one international and one national expert workshop held in 2015 in Helsinki, Finland. The international workshop focused on the general socio-economic development of the region, while the national workshop focused on the role of Finland in the Arctic development. Both workshops were conducted via participatory futures methods.

Findings: The first workshop resulted in two two-dimensional scenario matrices, which were further developed into six scenarios filling up a three-dimensional scenario space in which the dimensions represent 1) the initiator of the development (public-private); 2) the environmental status of the region (clean-dirty); and 3) the general perception about the region (open-closed). The six scenarios (Wild West, Roman Empire, Middle East, Silicon Valley, Antarctic and Shangri La) aim at describing conditions and the development of resource extraction, tourism and shipping sectors in the EA in 2040. The second workshop resulted in three futures tables with three perspectives: general development, maritime and tourism. These were further developed into three narratives reflecting the future of the region from the perspective of Finland and the selected sectors.

Significance for practical solutions: The need to adapt to the changes depends on the scenario. In most of the scenarios, commercial and societal activities increase in the EA. Due to this and mounting uncertainties related to climate and sea ice, the WMSs currently available in the area are not at the level required for the growth in activities. WMSs have a major role in enabling the security and sustainability of the development in the Arctic, and their improvement is a key component in the short-term adaptation process. However, it is not yet clear whether the improvement is a demand-pull (enhanced by growth in activity) or a supply-push (enhances growth in activity) process. This will be studied in 2016. The understanding of the nature of the deployment of WMSs will affect the future strategic development of general and tailored WMSs, potentially improving the safety and security of different operations.



ABSSUB-1081

SC 7.1 Offshore is onshore

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Research question: Climate change means that increased shipping and other maritime activities in the Arctic create new and enhanced risks that must be mitigated with innovative technologies, policies and structures. Iceland is well located in the Arctic to provide support for Mass Rescue Operations (MRO) in the area, and the small country already offers strong support for logistics, medical treatment etc. There is, however, a need to strengthen these capabilities even further to mitigate the risk of large-scale disasters such as cruise ship emergencies in the Arctic, especially within onshore coordination of offshore resources. Given the extreme distances and remote and sparsely populated areas there is a special need for establishing structures that can quickly be scaled up in case of large emergencies. One suggestion is to develop parts of the former US Naval Air Station Keflavík, which was abandoned by the Americans in 2006, into an International Rescue Hub. This mechanism should be able to function as a regional hub for MROs and allow for quick strategic deployment of rescue personnel and equipment, reloading/storage, tactical insertion, medical evacuation, command and coordination etc.

This paper investigates how such a mechanism could and should contribute to the overall resilience of the Arctic from a policy, logistics, international cooperation, security and military perspective.

Methodology: Under the overarching theoretical framework of resilience (enabling complex socio-technological systems to adapt to rather than deflect sudden, unexpected impact/stress) this paper investigates the problem through a policy analysis, including a feasibility study in the form of an expert workshop that will be held in Keflavík in December 2015. In addition the researcher has recently conducted field work in Iceland and Greenland during the ARCTIC RESPONSE 15 exercise that for the first time rehearsed the Hub-concept. Three sub-set Social Network Analyses were carried out, exploring emerging informal networks of knowledge sharing among the Target Audience.

Findings: Initial findings show that building a strong Hub-mechanism in the Arctic is not so much about logistics and practical issues as it is about designing and rehearsing abilities to coordinate and communicate among many different actors under time pressure.

Significance for practical solutions: The Icelandic Coast Guard, who operates the Keflavík Air Base today, is a partner in the NORDRESS research project, and the findings feed directly into policy work at the ministerial level.



ABSSUB-663

SC 7.2 Adaptation to climate change in Nunavut: where are we at and where do we go from here?

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Research question: Our study asks: what is the current state of adaptation to climate change at the community, territorial, and federal level in the Canadian northern territory of Nunavut?

Methodology: To assess the state of federal, territorial, and community adaptation in Nunavut we employed systematic data collection methods. We gathered our information through web-based searches of publically available grey literature focused on adaptation and climate change for all government jurisdictions. A total of 96 web searches were made between November 2014-January 2015, yielding a total of 7243 hits reviewed and 163 initially kept for further review. This resulted in a total of 252 potential inclusion documents, where 103 documents were included for review and coded to extract discrete adaptation initiatives. From these results we created a database of adaptation initiatives in Nunavut (n=762) and used this database to perform descriptive statistics that formed an adaptation baseline for the territory.

Findings: The high number of discrete adaptation initiatives found show that adaptation is on Nunavut's radar. However, a high percentage of adaptation is in the planned or recommended stage, suggesting that adaptation action may still be in the initial stages. Key trends highlight that extreme weather events and weather uncertainty, permafrost and vegetation change, and sea-ice change are the most common climate change impacts driving adaptation. When looking at jurisdictional patterning of adaptation type, the federal level emerges as a leader for funding and resources provision, territorial level shows high percentage of infrastructure and innovation adaptations, and capacity building initiatives are most common at the community level. Evaluation of adaptation is low across all jurisdictions. Based on publically available information, reported adaptation also varies greatly across communities, with communities that have adaptation plans, such as Arviat and Iqaluit, emerging as leaders.

Significance for practical solutions: While we know that adaptation is taking place in the Arctic (and globally), our understanding on who is adapting, to what stresses, where, and in what way is still limited. There are also few studies examining if the adaptations taking place are consistent with the risks posed by climate change and monitoring if we are adapting more over time. This research addresses these gaps, as well as highlights where adaptation is underway in addition to sectors and locations where adaptation is low. Decision-makers can use this information to target funding and resources to needed-areas and plan adequately in order to move forward. Our baseline also acts as a starting point for tracking adaptation in Nunavut over time to monitor progress. Globally, this systematic method for baseline creation can be applied across other regions and in other sectors (e.g private or non-governmental sector) and provides opportunities for comparability across scales and locations.



ABSSUB-1156

SC 7.2 Vulnerability and adaptive capacity of Inuit women to climate change: a case study from Nunavut

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Research question: Climate change impacts in the Arctic will be differentiated by gender, yet few empirical studies have investigated how. This research seeks to identify and characterise how Inuit women experience and respond to climate change impacts within the context of multiple environmental and socio-economic stresses.

Methodology: We use a case study from the Inuit community of Iqaluit, Nunavut, to identify and characterise vulnerability and adaptive capacity of Inuit women to changing climatic conditions. Ford and Smit's (2004) vulnerability approach was employed to incorporate the knowledge and observations of female Inuit residents in Iqaluit and key informants to document and characterise current exposure, sensitivity, and adaptive capacity. Interviews were conducted with 42 Inuit women, and were complemented with focus group discussions, photovoice sessions, and participant observation to examine how women have experienced and responded to changes in climate already observed.

Findings: Three key traditional activities were identified as being exposed and sensitive to changing conditions: berry picking, sewing, and the amount of time spent on the land. Several coping mechanisms were described to help women manage these exposure-sensitivities, including altering the timing and location of berry picking, and importing seal skins for sewing. The adaptive capacity to employ these mechanisms differed among participants, however, a function of mental health, physical health, traditional/western education, access to country food and store bought foods, access to financial resources, social networks, and connection to Inuit identity. The study finds that gender roles result in different pathways through which changing climatic conditions affect people locally, although the broad determinants of vulnerability and adaptive capacity for women are consistent with those identified for men in the scholarship more broadly.

Significance for practical solutions: By providing a baseline assessment of the ways in which climate change impacts the lives of Inuit women this research highlights the female experience with the aim to inform climate change adaptation policy and planning development. This research further supports the important role food security, mental health, and fostering a strong Inuit identity play in resilience and adaptation to climate change. Findings also highlight that Inuit women are less directly impacted by the effects of climate change than men and in this way are less vulnerable to direct climate change impacts.



ABSSUB-1277

SC 7.2 How to evaluate climate change adaptation: a pilot study in Arviat, Canada

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Research question: The research question for this project is: "How can we evaluate effective climate change adaptation in a permafrost environment? A pilot study using the Terrain Analysis Project in Arviat, Canada." The research question for this project is: "How can we evaluate effective climate change adaptation in a permafrost environment? A pilot study using the Terrain Analysis Project in Arviat, Canada."

Methodology: Utilizing semi-structured interviews (n=19) with key project stakeholders, this research builds on previous literature of adaptation tracking and evaluation, to create an adaptation evaluation framework and empirically apply the framework to a community level project, in Arviat, Nunavut.

Findings: The presentation will profile some emerging findings from the community level project, as an illustrative case study. However, the overarching emphasis will focus on examining the methodology developed for evaluating adaptation initiatives in Arctic communities, to answer key evaluation questions including; what linkages and barriers exist in transferring project outcomes into adaptations, and; how can we address identified gaps or barriers to ensure effective adaptation occurs?

Significance for practical solutions: Whilst the insights gained from this project will be specific to Arviat, it is expected that the evaluation framework created will be flexible and general enough to be applied to other adaptation projects taking place in Arctic communities to address gaps and barriers to ensure adaptation actions translate into effective adaptation.

ABSSUB-1483

SC 7.2 How's life on Svalbard?

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Research question: During the last couple of decades, a significant expansion of natural resource exploitation and industrial activity throughout the Arctic has been witnessed. The increase of this exploitation of resources in the Arctic is causing significant changes to the bio-ecological and socio-cultural systems. In addition, tourism is rapidly increasing throughout the Circumpolar north. It is estimated that the high arctic archipelago of Svalbard is receiving as much as one-fourth of this volume of tourists. In Svalbard, understanding the needs of market and users groups, and finding ways of integrating this in land-use planning frameworks is a central task. Thus, the purpose of this paper is to identify and understand more about the experiences of the residents of Svalbard. Specifically, we wanted to identify the relationship that residents have with the natural environment in Svalbard.

Methodology: A total of 54 participants were recruited for a survey by electronic means and by word of mouth on the streets and public places in Longyearbyen. Our target participants were individuals residing Svalbard. Participants were told that the survey was aimed at identifying and understanding more about the



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experiences of the residents of Svalbard. After participants gave informed consent, they began the survey by providing information about their stay in Svalbard and on the natural resources there. The survey was translated into both Russian and Norwegian allowing us to assess the transnational differences between the different residents of the island.

Findings: Although work and salary are the most important reasons for coming to Svalbard for most of the respondents, many of them also chose to go because of the natural environment and the possibility of adventure in an extreme environment. Tourism and research are seen as the most important opportunities of their future economy, while coal mining is expected to disappear. Contrary to our expectations, most respondents do feel part of a local community. The majority considers the environment to be vulnerable, and most make an effort to limit their impact on the environment.

Significance for practical solutions: This research is exemplary for many other communities in the North; 10% is indigenous and 90% are migrants from the south (sometimes since several generations like in Murmansk). At this point in time, there does not seem to be much literature on these 'southern' populations. Their attitudes and behaviour will for a large part determine the future of the natural resources in the Arctic.

ABSSUB-1295

SC 7.3 Boundary arrangements for adaptation in primary industries

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Research question: Can boundary work theory help explain the variable salience of the adaptation issue across sectors?

Methodology: The analysis draws on material from research conducted in Vestvågøy municipality, Nordland county, Northern Norway, and the counties of Sogn og Fjordane, Hordaland and Møre og Romsdal in Western Norway, over the past seven years. The research is primarily sector-based community studies of adaptation strategies and assessment of communities' vulnerability to interlinked climatic and societal changes, as well as a study of regional government agencies effort to coordinate adaptation across sectors and at the local level. Downscaled projections for future climate were discussed with the informants along with scientific knowledge about the impact of climate change on agriculture and fisheries and municipal spatial planning. Semi-structured interviews were carried out with 43 individuals including fishery sector actors (n=20), municipal officers (n=8), farmers (n=9) and regional governance actors (6). Document analysis was carried out on local and regional planning documents (spatial plans, regional climate plans, risk and vulnerability assessments).

Salience of climate adaptation is indicated by a) attribution of possible future livelihood challenges to climate change b) relative importance (threat to livelihood compared to other exposure-sensitivities) and c) the manifestation or extent of adaptive responses.

Findings: The results indicate that the need to adapt is perceived differently, if at all, amongst different actors in municipal spatial planning, agriculture and fisheries. Given that a well-functioning science-policy interface is paramount for adaptation, theories of boundary work can help explain how this can be achieved. The aim of this paper has been to investigate the extent of boundary work in the coordination of adaptation planning by



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regional governance actors. Our findings show that the means of coordination employed by the regional governance actors involves boundary work, but the results indicate that this is currently not sufficient for making adaptation a salient issue at the local level. Also, our findings indicate that the hybrid management space created by the regional governance actors holds significant potential for increasing this salience if local users and their knowledge, get more strongly involved in co-producing knowledge for adaptation planning (Cash et al., 2003).

Significance for practical solutions: Boundary work theory is a necessary and important component in analysing adaptation planning and governance, as this policy area is, to a very great extent, dependent on bridging science and policy.

ABSSUB-1474

SC 7.3 How narratives in shaping adaptation and adaptive capacity to climate change in Northern Norway

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Research question: What are the most salient preconditions for adaptation and transformation in primary industries in the context of climate change? Are there particular preconditions for the multiple Arctics?

Methodology: Case studies in northern Norwegian communities. Semi-structured interviews with primary industry actors and agents of change. Document analysis of current and past adaptation strategies and of policy documents.

Findings: The paper discusses the most salient preconditions for transformation in primary industries, in the context of climate change and the role of scientific knowledge and perceptions of risk in shaping such preconditions in national policy, interest organisations, businesses and individual actors in the primary industries. The "reality" of scientific knowledge does not originate solely from science itself, but by the legitimacy gained through social practices and organisation (Jasanoff 2004), and knowledge produced in efforts to move from knowledge to action for sustainable development needs to be salient and credible (Cash et al. 2003). Climate risks call for transformative changes in society beyond incremental adaptation and mitigation measures. Primary industries, (fisheries, agriculture, reindeer herding) make ideal test cases. Their perceptions of risks associated with climate change determine the degree to which they accept scientific knowledge as salient, credible and legitimate, and on acceptance of policy action or if they want to instigate change themselves. We surmise that perceptions of risk shape the observed inertia to respond to the overwhelming evidence of climate risks. This is found across scales and agents of change requiring insights from both cultural theories of risk (CTR) and STS.

Significance for practical solutions: The paper will close an existing gap and look into how boundary work processes should be facilitated in order to balance salience, credibility and legitimacy and thus maximize uptake in policy. We approach this challenge by looking at how climate change science can be communicated, translated and mediated, with a particular focus on learning for uptake in policy.



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ABSSUB-1522

SC 7.3 **Avalanche risk in Norwegian communities: risk perceptions and boundaries of local adaptive capacity**

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Research question: What are the characteristics of resilience and adaptive capacity in communities affected by avalanche risk in Northern Norway?

Methodology: The paper employs an interdisciplinary methodology. Qualitative interviews with local residents and governance authorities in avalanche exposed regions constitute the primary data source. Interviews are complemented with document analysis and regional climate scenarios.

Findings: The paper will present preliminary findings on how local residents in two avalanche exposed communities in Troms County, Norway, perceive and respond to risk. Northern Norway is due to its topography, climate and patterns of settlement exposed to avalanches, leading to road closures with subsequent disruption in transportation of people, goods and services. While climate change is projected to alter the prevalence and timing of avalanches in Northern Norway, well-functioning, reliable and predictable infrastructure is increasingly important for the social and economic fabric of remote Norwegian communities. The paper discusses local adaptive capacity and social resilience in the light of differentiated risk perceptions within the studied communities and across governance authorities. The findings illustrate that local residents have developed and incorporated a range of adaptive strategies in their everyday lives to minimise individual and community disruption in the event of road closure and avalanche risk. While residents express a high resilience towards the everyday disturbances caused avalanche disruptions, the current level of risk posed to individual and communal safety and well-being are by many seen as unacceptable with the potential to undermine future viability and attractiveness of these communities. The paper argues that although local strategies may be sufficient to maintain current community functions, they are insufficient to respond to climate change and growing demands of personal safety. The preliminary analysis highlights how perceptions of risk, safety and desirably local development influence boundaries of local adaptive capacity.

Significance for practical solutions: The paper broadens the understanding of situated and lived risk associated with avalanches and provides knowledge about how society adapts to climate change challenges. In addition, it provides insights useful to social transformations and adaptive management in areas already exposed to climate induced hazards as well as the societal capacity and willingness to adapt to change with relevance to the broader Arctic region.



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SC 7.3 Adaptation in Canadian Arctic coastal ecosystems: dissonances and challenges with M&E indicators

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Research question: Several environmental experts and NGO emphasize the magnitude and velocity of climate change (CC) in Arctic ecosystems. Evidences suggest that CC are major carriers of harms to ecosystems and to the well-being of populations (mostly Inuit). CC may allow the opening of new shipping routes, which exacerbates socio-economic pressure on the Frobisher Bay, home to Iqaluit, the capital of Nunavut. Several government and community initiatives begin to be implemented, in order to facilitate climate change adaptation (CCA). Despite efforts made, nothing is done to measure CCA in order to inform decision-making. Our text proposes to advance knowledge about this situation, highlighting the issues and challenges associated with indicators in the monitoring and evaluation (M&E) of CCA in the Canadian Arctic context. Our text deals with two questions: Q1) How do local communities perceive CC in the Arctic and how vulnerabilities impact these perceptions and attitudes? Q2) How does local collective action assesses CCA and what can be counted in order to measure performance and progress in adaptation?

Methodology: The text presents the results of a field investigation conducted in Iqaluit (north of Canada). During 2015, we have conducted several observations and interviews with stakeholders and affected communities. Empirical data were also collected through a review of statistics and annual reports produced by Canadian agencies on site. Our observations, interviews and data are analysed using mixed methods and triangulations.

Findings: Our paper advances knowledge regarding three challenges: i) The conceptual dimensions of CCA in coastal ecosystems, especially in the Arctic, bring 2 dissonances; a) opposing paradigms and ways of thinking on the assessment of CCA (aboriginal approach versus governmental approach); b) contrasting feelings of vulnerability among local communities towards growing industrial activities (shipping, trading, energies, etc.). In this regard, indicators are dissonant and embryonic.

ii) The velocity of changes: Local communities are progressively losing their ancestral knowledge (hunting, trapping, fishing, etc.). New vulnerabilities are appearing (water quality is worsening, accumulation of waste, impaired navigation caused by the detachment of blocks of ice, etc.) and new opportunities are arising (employment, revenue, tourism, etc.). Our paper has identified 15 indicators that can be tested and implemented progressively.

iii) The conservation and natural wildlife: Many animals are facing extinction, mainly as a consequence of CC, as well of their overexploitation by hunters, trappers, fishermen, etc. Local communities are growing and more resources are required to meet their needs. Indicators measuring conservation are raising controversial debates and recalibration.

Significance for practical solutions: This paper suggests different recommendations for decision makers and evaluators, mainly in terms of cultural skills and with new approaches based in participation and resilience.



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PLANNING AND EVALUATION**





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SC 8.1 A regional approach to assess transportation infrastructure vulnerability to extreme weather events

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Research question: Extreme weather is creating a growing challenge for disaster managers and transportation planners. The impacts are far-reaching, including human casualties, damage to physical assets, business discontinuity, lack of transportation mobility, and impairment of the lifeline upon which our society depends. This prompted the Tennessee Department of Transportation (TDOT) to perform an assessment of critical transportation assets in the state that are most vulnerable to extreme weather events through a 2040 planning horizon. Tennessee is unique in being an inland region whose climate and topography expose the state to a variety of extreme weather events, and which are not dominated by concerns associated with sea level rise and storm surge. Moreover, all significant passenger and freight transport modes and support facilities were considered across a large region.

Methodology: The study required a methodological approach consisting of the following steps: 1) develop an inventory of transportation assets, 2) identify those assets considered critical to transportation system operation, 3) determine extreme weather scenarios to which these critical transportation assets may be exposed, 4) assess the impacts to each critical asset in terms of damage and system disruption to respective extreme weather scenarios, 5) combine this information into an overall measure of vulnerability.

Findings: Critical transportation assets in the state are most vulnerable to strong winds and flooding. There is also greater vulnerability at locations where both rockslides are prevalent and there is an expected increase in heavy precipitation frequency/severity. TDOT is proceeding with a second phase of the extreme weather initiative, which will more narrowly focus on adaptation planning for a subset of its most vulnerable critical transportation assets.

Significance for practical solutions: A screening tool has been developed to help transportation planners improve their understanding of where to focus adaptation resources, using a methodology that is transferable to other locations. Using this approach, TDOT has identified several opportunities for integrating project results into agency activities that are likely applicable to other transportation organisations: 1) enhancing the priority of transportation investments that reduce vulnerability or provide additional capacity for at-risk transportation assets, 2) changing the way transportation infrastructure is designed, constructed & repaired, 3) modifying maintenance plans & procedures, 4) integrating vulnerability assessment results into hazard mitigation planning & emergency management, 5) including the impacts of extreme weather as part of the environmental review process, and 6) identifying new data collection activities to better characterise & monitor the condition of vulnerable assets.



ABSSUB-1532

SC 8.1 Knowledge gaps in risk management for critical infrastructure: insights from four case-studies

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Research question: Empirical and anecdotal evidence suggest a gap between the technical assessment of risk and risk management in practice. This raises the question whether seemingly insufficient risk management and underutilisation of risk assessment tools reflect deliberate decisions or whether they reflect gaps in tools, method or data. In each of the case studies we aim to: (1) characterise the risk problem and (2) identify the main knowledge gaps in risk management of critical infrastructure.

Methodology: Based on observations from the literature and dialogue with stakeholders, we identify and characterise knowledge gaps in risk management. Using a decision-making framework for risk management, we identify and highlight how characteristics of risk knowledge affect different steps in the risk management framework. The characteristics of risk knowledge include: uncertainty (epistemic and aleatory), complexity, ambiguity (interpretative and normative). The case studies are: winter storms affecting power plants, Finland 2011; floods affecting road and rail infrastructure, Norway, June 2011; heavy precipitation affecting road network, the Netherlands 2007; storm and heavy rainfall affecting road network, Spain 2012. In each case study, we first characterise the risk problem that appears most relevant for the case study, highlighting the most relevant knowledge gaps in each. Finally, based on the identified knowledge gaps we draw general conclusions and suggest tools and methods relevant for the risk management in each case.

Findings: In a number of the case studies aleatory uncertainty-induced risk problems, particularly related to predicting local weather extremes such as heavy precipitation events, represented an important challenge. These challenges will be further exacerbated due to climate change. In Norway and Spain epistemic uncertainty related to insufficient hazard maps also represented a challenge. In Finland complexity-induced risk problems had a negative impact on crisis management: power shortages led to interruptions on the telecom network, again leading to communication problems among parties involved in crisis management. Ambiguity - in particular normative - is a main challenge in several of the cases. For example, several municipalities located in hazard prone areas in Norway do only to a limited amount use risk and vulnerability analyses as a basis for spatial planning.

Based on the characterisation of the risk problems we offer a number of practical suggestions for closing the knowledge gaps and improving risk management. We hope to be able to present these at the Adaptation Futures 2016.

Significance for practical solutions: Based on the characterisation of the risk problems we offer a number of practical suggestions for closing the knowledge gaps and improving risk management. We hope to be able to present these at the Adaptation Futures 2016.



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SC 8.1 Iterative Climate Risk Management for taking adaptation to the next level? Insights from Austria

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Research question: Sharply increasing losses and impacts from extreme events, such as floods and droughts, have highlighted the need for climate adaptation. To foster climate adaptation in practice it is required to address risk comprehensively by linking adaptation to disaster risk management (DRM) beyond rhetoric. We test the relevance and implications of operationalizing the emerging concept of Climate Risk Management (CRM) to that end for the case of Austria, a country that has been subject to recurrent flooding, leading to massive losses and considerable stress to public finance, and ask (1) are DRM and CCA coming together in practice and policy in terms of a CRM approach? (2) If considered useful overall, what are approaches and methods for helping to take CRM forward in and beyond Austria?

Methodology: We provide evidence generated while using a CRM approach with DRM and adaptation policymakers and experts in Austria. We employ an approach building on multiple lines of evidence and various methods, comprising of an extensive literature review on the current CCA practice dealing with extreme events and natural hazards in Austria, analyses of the Austrian public budget and expert interviews with stakeholders in Austria, and risk-based economic modelling.

Findings: The stakeholder process has pointed out that in the current Austrian DRM practice climate change considerations are not explicitly taken into account. Nevertheless, the experts' statements revealed that climate change considerations are implicitly taken care of and by continuously reviewing and integrating new scientific knowledge on climate change the practitioners are adjusting their decisions over time with evidence. Hence, we find that the DRM practice in Austria can be seen as early adaptation to climate change, addressing the existing adaptation deficit and mainstreaming climate change in decision processes within an iterative CRM approach. The empirical budget analyses has shown that recent extreme events have already put Austria's major risk financing instrument – the disaster fund – under severe pressure and made budget diversions necessary. Under future climate and socioeconomic developments climate related risks are expected to increase substantially, leading to potentially even stronger fiscal implications in the future.

Significance for practical solutions: To proactively address future contingent climate-related fiscal liabilities, we suggest to foster linking climate adaptation with DRM in practice by implementing a comprehensive CRM approach. In such an approach a mix of policy measures is needed, tailored to the particular requirements of different layers of climate related risks. Our findings and conclusions are of relevance beyond the case of Austria: Many countries and communities are feeling the impact of changes in extreme events and are looking for robust strategies to reduce and manage the risks. To that end a broad-based and actionable perspective on CRM, as demonstrated here, is fundamental.



ABSSUB-635

SC 8.1 Risk perception as a driver for risk management policies

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Research question: Risk is generally defined as the “combination of the probability of the occurrence of an event and its negative consequences” (UNISDR, 2009). But the fact is that risk differs among cultures regarding different features such as the context, causes, benefits or damage. Risk perception is the subjective valuation of the probability of happening of an event and how concerned individuals or groups are with the consequences (Sjöberg, 2004).

Our study is based on an existing framework for risk perception (Rehn and Rohrmann, 2000). We analyse the characteristics of the risk perception development in case studies and how the perception of the group drives the action to manage the risk. We do this to achieve an overview of the conditions that let stakeholders join each other to improve risk management especially when governments are not reacting properly.

For our research, attention is paid on risk perception of Multi-Sector Partnerships not taking into account the individual level of risk perception. We focus on those factors that make risk management effective and increase resilience. Multi-Sector Partnerships, considered as significant governance structures for risk management, might contribute to reduce vulnerability in prone areas to natural hazards and disasters. The Multi-Sector Partnerships used for our research are existing partnerships identified in the cases studies of the European project ENHANCE.

Methodology: We implement a survey based on the Cultural Theory (Douglas and Wildavsky, 1982) and the Protection Motivation Theory (Rogers, 1975). We analyse the results using the Qualitative-Comparative Analysis proposed by Ragin in 1987.

Findings: The results show the main characteristics of a risk culture that are beneficial to manage a risk. Those characteristics are shaped by the perception of risk of the people involved in the partnership, which in turn shapes their risk management. Nevertheless, we have to recognise that there is no “one-size-fit-all” solution and that Multi-Sector Partnerships are shape by the hazard they face and also by the social, political and historical background of the area where they are.

Significance for practical solutions: This kind of analysis shows to recognise under which conditions multi-sector partnerships will act better to face risk as governmental actions. We aim at transferring this knowledge to risk prone areas to support the enhancing of risk management.



ABSSUB-1011

SC 8.2 A structured climate vulnerability assessment approach - concepts and lessons learned

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Research question: An in-depth assessment of the climate vulnerability or the climate risk of a given system is often seen as a basic requirement for a proper adaptation planning. Furthermore, a subsequent repetition of such an assessment could even serve the demand for monitoring the adaptation progress and success. Various generic guidelines and frameworks exist. However, most of them lack instructions how to operationalize the assessment in such a way that comparison in time and/or space would be possible, which is a pre-requisite for monitoring purposes.

Methodology: In this talk we present a structured methodological framework for climate change vulnerability assessments based on a set of impact chains and indicators, which are co-developed with stakeholders. As Impact Chains, we define conceptual models describing climate impact as cause-effect relationships within a socio-ecological system. The approach allows the integration of different data sources such as measurements, models, surveys, expert interviews as well as participatory appraisals and it explicitly addresses normative aspects in a participative manner.

This framework is applicable for vulnerability assessments from the national to the local scale and follows the full planning cycle of the adaptation process starting with the identification of the adaptation demand and ending with the selection of measures to monitor and evaluate the success of adaptation in reducing vulnerability. The approach has been applied in three case studies in least developed countries at different scales from the local to the national. The here introduced approach was developed and tested within the GIZ project "Vulnerability Sourcebook".

Findings: In all case studies the stakeholder of the system appreciated the systematic and consistent as well as the participatory approach and stressed the benefit for their adaptation activities. Already the clear conceptual illustration of "their" vulnerability through impact chains was perceived as a relevant result, which already helps to identify adaptation demand and options. Measurable indicators and the discussion on potential data sources supported the expressed request by the stakeholder to systematically prioritize adaptation demand and monitor their success. However, we were also facing challenges within the assessment. One of those challenges is the strong requirement on resources and experience for data driven analysis, particularly if it is spatially explicit. A second challenge, but also a reward, is the integration of qualitative information in the assessment scheme. Finally, the approach supports the awareness building amongst stakeholders, that a number of normative decisions have to take within a vulnerability assessment.

Significance for practical solutions: The result is a set of guidelines and instructions (Vulnerability Sourcebook). These instructions have already been tested under "real world conditions" and are of significant relevance for adaptation planning.



ABSSUB-1132

SC 8.2 Making climate change vulnerability assessment understandable and useable on a local level

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Research question: Even though climate change impacts usually happen at a larger scale the effects are most relevant for individuals and households on a local level. At that scale it is decisive how much is understood about the current state of vulnerability, how well this is translated and transformed to adaptation measures and how easy these measures can be further adapted after future changes will occur. Measures need to be accepted and implemented by decision makers as well as the affected public at every level from local to global. Accordingly the research question underlying this work is "how to make vulnerability assessment easily available, understandable and useable for decision-makers and affected people?"

Methodology: The approach chosen is to involve local knowledge and individual perspectives already at the early stage of assessing vulnerability through a participatory modelling approach. First data have been gathered in two case studies in Mexico and South Africa. To create a multifaceted picture of vulnerability regional demographic data as well as recent findings from scientific research are added. Including regional climate change trends on a socio-ecological system basis allows an estimation of environmental changes affecting directly on socio-economic benefits of people.

Findings: First preliminary results show vulnerability at a local scale is highly variable according to different environmental settings and human perceptions. Furthermore the importance of communication between rural communities and local governments has been emphasized. Working with people of different educational levels shows the need for information being easily understandable also in a non-scientific context.

Significance for practical solutions: Results visualized in different ways shall be evaluated by different potential user groups. The finalized output results can be used as direct support for decision-makers to improve the current situation and decrease specific vulnerability where it is needed most urgently. Two further development steps of the method shall 1) allow people to assess their vulnerability themselves and 2) involve more future scenarios as well as management scenarios in a more dynamic vulnerability approach, supporting not only the management of current but also of possible future vulnerability states.

ABSSUB-1078

SC 8.2 An assessment of relative vulnerability to floods by using data envelopment analysis in Bihar, India

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Research question: As the modern human civilization has been experiencing increasing incidences of damages due to climate extremes such as floods over the years, vulnerability assessment has gained prominence in various geo-spatial settings. Indeed, at a given scale, it is important to ask: what makes an individual,



community, and a region to suffer more than the others when they face the same disaster? Commonly used composite vulnerability indexes inform decision makers to employ effective mitigation strategies and develop suitable adaptation policies. However, such indexes are sensitive to the subjective and a priori weight selection to the sub-indices when they are aggregated to achieve the final vulnerability scores. Moreover, these indexes also ignore the various spatio-temporal aspects with which hazard specific vulnerability shapes over the years.

Methodology: In this paper we attempt at addressing aforementioned challenges and use Data Envelopment Analysis (DEA) to explain the relative spatiotemporal variation among the various flood affected districts of Bihar by taking the relative efficiency of disaster system's input-output into account. We employ data reflecting on various damages and loss as outputs, and gauge station wise classified hydro-meteorological data, physical factors, vegetation, and various socioeconomics parameter as inputs for the period 2001-2011. In our model, we index neighbouring districts precipitation with district elevation estimated by projecting ASTER DEM of 30m resolution on the digitized boundary of 1:100,000 scale Survey of India map under the arcGIS framework. Further, we employ principal component analysis to incorporate only linearly unrelated indicators. Results from employed classic C2R method explain that among different spatio-temporal domains we can compare the relative vulnerability of districts facing the same disaster.

Findings: Final vulnerability scores illustrated in the colour coded Bihar map reflects that some of the central Bihar districts, geographically positioned in the north of river Ganges, are the most vulnerable. When compared to the cluster of least vulnerable districts we find that its mainly because of the poor socio-economics, sparse vegetation, and presence of Adhwara groups of rivers which brings the annual flood fury.

Significance for practical solutions: Given the unique geographical location of various north Bihar districts drained by perennial Himalayan rivers, this region has a long history of floods. Nonetheless, the extent literature reflects paucity on relative flood vulnerability measurement, and arguably thus, this paper contributes to fill this gap. Additionally, the results provide direction in understanding vulnerability at the more micro scale when it is complemented with composite vulnerability index. For a better implementation of disaster mitigation, enhancing capabilities, and adaptive capacity our findings can help in formulating suitable policy design.



ABSSUB-1101

SC 8.2 Mapping vulnerability of communities to climate change in the Helsinki Metropolitan Area, Finland

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Research question: It has been recognised that extreme weather events associated with climate change, such as flooding or heatwaves, do not affect all individuals and communities to the same extent. People's vulnerability – understood as the extent to which their well-being may be negatively impacted by flooding or heatwaves – is influenced by their personal characteristics, socio-economic situation and the character of the physical environment they are living in. However, the characteristics of local communities that contribute to their vulnerability to climate change are rarely investigated by local authorities in the process of flood risk management or preparedness planning; these are usually driven by the probability of the hazard occurring, or by the spatial concentration of population and economic assets at best. In this paper we discuss a methodology of collating and analysing data that can provide local authorities with information about the spatial distribution of vulnerability, and thus facilitate the development of socially just adaptation strategies.

Methodology: The methodology was based on the assessment of social vulnerability carried out by Lindley et al (2011) in the context of the UK. In the methodology, a number of indicators from census and national statistics was identified pertaining to the sensitivity of communities, their ability to prepare for, respond to or recover after climate-related events, and the characteristics of the neighbourhood that mitigate or increase their exposure to flooding or heatwaves. The indicators are then standardised and combined into an index of social vulnerability to climate change. The data for the Helsinki Metropolitan Area was collected for 5 - 10 indicators using area-wide data available for a grid of 200x200m. This offers a fine-scale data allowing drawing conclusions about spatial distribution of vulnerability of communities.

Findings: The data indicates spatial concentrations of vulnerability in certain areas of the Helsinki Metropolitan Area, which may have implications for the resilience of the communities in these areas. A detailed analysis of the data is ongoing.

Significance for practical solutions: In the Helsinki Metropolitan Area, adaptation policies have mainly been based on the exposure of the communities to climate impacts and much less on the capacity of the communities to prepare for and to cope with the impacts. In planning of future actions, it is therefore important to shift focus to the most vulnerable communities in the area, to reduction of their vulnerability and to strengthening of their resilience. The vulnerability mapping exercise makes these communities visible in a way that is easy for the planners and decision makers to understand. Also, the indicators defined in the process give valuable information of several factors of vulnerability for planning and decision making. The method can also facilitate cooperation with other actors such as NGOs and new sectoral public services.



ABSSUB-1146

SC 8.3 Model of integrated impact and vulnerability evaluation of climate change in South Korea

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Research question: Climate change affects not only climate phenomena but also natural eco-system and socio-economic system in a respective way or complex way reacting with each other. So, it is necessary to figure out the impacts and vulnerability by the climate changes scientifically both in each factor and on a complex and integrated perspective.

Methodology: There have been numerous researches around the world on the development of integrated evaluation models such as CLIMASAVE in Europe, JULES in UK and NEXUS in Japan. In South Korea, research group for MOTIVE (i.e. Model Of inTegrated Impact and Vulnerability Evaluation of climate change) was launched on May 2014 as a part of the national project of environmental technology for climate change, supported of the budget under the Ministry of Environment. In this conference, we aim to introduce MOTIVE and discuss the difficulties in the developing process.

Findings: MOTIVE is used for utilizing for designing science-based adaptation to tackle climate change. In detail, MOTIVE is targeting for 2030, 2050 and 2080 of South Korea for seven sectors and six policy issues, associated with climate change. Sectors include health, water, agriculture, forest, eco-system and ocean/fishery, with considering disaster inductive factors at each sector. Policy issues include land management (SOC etc.), vulnerable group management, safety management (flood, landslide etc.), preservation area management, food production, and supply service (water etc.). Development of MOTIVE is conducting in four stages for seven years until April 2021 by Korea Environment Institute, Seoul National University, Korea University, and National Institute of Ecology and so on. The step-by-step goals are designing model to respond to policy issues in Phase I for 2014, improving individual & linkage model and modulating evaluation model (within sector) in Phase II for 2015-2016, modulating evaluation (cross-sectors) in Phase III for 2017-2018, and risk-based evaluation considering policy linkage in Phase IV for 2019-2020.

Significance for practical solutions: Finally, MOTIVE will be implemented in user-friendly web-based system, used for central government, local government, researchers and industry. Through these researches, we expect to scientific assess climate change impacts and vulnerability on technology side, minimise mal-adaptation by prioritizing based on scientific analysis on policy side and increase employment and excavate new industries for climate change adaptation on industry and economy side.



ABSSUB-812

SC 8.3 The value added of combined sector and macroeconomic model use in adaptation assessment

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Research question: Climate change impacts and related adaptation measures are assessed both by sector specific models and by generic macroeconomic and integrated assessment models. These models may produce quite different results following from the same original impacts, which is logic, considering their different purposes, but this can be confusing for policy makers. In the FP7 project ToPDAd the question arose to what extent and under what conditions the concerted use of economic sector models and macroeconomic models in the assessment of climate change impacts and related adaptation efforts generates value added as compared to the separate – less complex and better tuned – use of these models. Furthermore, can differences be explained satisfactorily to policy makers and other experts?

Methodology: Based on shared climate and socioeconomic scenario pathways (RCP/SSP combinations) 7 case studies at different spatial scales were carried out concerning impacts and adaptation potential in one or several of the sectors energy, transport and tourism, while trying to distinguish between stages of adaptation (from none via automatic/autonomous to planned). Three different macroeconomic models were used to explore (1) the joint effects of mitigation and adaptation efforts at macro level, (2) use results of selected case studies to assess effects of more precise sector impact information, and (3) explore labour market effects of climate change impacts on public health and differences in effectiveness between proactive and reactive infrastructure adaptation investment strategies.

Findings: Concerted use of sector and macroeconomic models can show that the eventual economic effects are substantially larger or smaller than the direct economic impacts shown in the sector models. That doesn't invalidate the latter results, but illustrates the existence of compensation and transfer mechanisms in (inter) national economies and helps to create a more nuanced policy prioritization. The identification of adaptation steps, which is very helpful for policy making, often cannot be fully implemented in neither the sector models nor the macroeconomic models. Yet, through unconventional set-ups some additional identification can be inferred.

Significance for practical solutions: Concerted use of sector and macroeconomic models is only useful, when based on common scenarios and when the same types of variables are involved. Combined use of a CGE model and a dynamic investment model to assess differences between proactive and reactive adaptation investment strategies appeared to be promising. With some effort differences between outcomes can be explained in a clear way.



ABSSUB-205

SC 8.3 Climate change, water scarcity and health adaptation in Southwestern Bangladesh

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Research question: Climate change may affect human health through multiple and interactive pathways that include the scarcity of safe water. However, impacts of climate change induced water scarcity on health and well-being are complex not least since about eighty percent of all illnesses in developing countries are variously attributed to unsafe drinking water and the spread of waterborne diseases. In Bangladesh, Southwestern region suffers from a severe safe drinking water crisis due to sea level rise, temperature and extreme events including more intense floods, droughts and storms. Taking into account, this research investigated the impacts of climate change on the water resources and human health of the coastal area.

Methodology: Based on safe water access and health care facilities, the questionnaire survey was carried out in two villages of Shymnagar upazila (sub-district) in Southwest coast. A total of 120 (60+60) respondents from two villages of Shyamnager upazila (sub-district) of Satkhira district was selected through systematic random sampling techniques for a household questionnaire survey.

Findings: Survey results reveal, the local community believes that climate change is having a substantial impact on freshwater and health. More than 70% of the respondents notice diarrhoea, dysentery and skin disease are the prime waterborne health risks that occur through climate related safe water scarcity. We suggest there are pathways to health adaptation to climate change effects and safe water scarcity through locally available adaptive practices such as use of pond sand filters, rainwater harvesting, importing potable water where there is active participation of Government, NGOs and community.

Significance for practical solutions: This study involved local people in their own examination of the effects of climate change on water resources and human health in the study areas. This has helped identify the suitable options of the local people in formulating a pathway for health adaptation strategies for coping with water scarcity as well as climate change in the context of coastal Bangladesh.



ABSSUB-1259

SC 8.3 Climate change adaptation in the EU. An integrated assessment for flood, agriculture and health

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Research question: This study applies a hard-link, dynamic-optimization, integrated assessment (IA) global model, AD-WITCH, to study optimal adaptation in Europe against three categories of climate change impacts: increasing intensity and frequency of river flood, changes in crop yields, and changes in mortality and morbidity from heat waves and salmonella. The final aim of the exercise is to compare and discuss the investment needs for adaptation in the EU under different socioeconomic development, climate change, and mitigation policy scenarios. Particular attention is devoted to analyse the interaction between mitigation and adaptation highlighting trade off and complementarities.

Methodology: Adaptation costs and effectiveness functions in AD-WITCH are calibrated using ad hoc sectoral studies using respectively a flood risk model, an agro-hydrological model, and extrapolating a reduced-form relation between temperature and health impact adaptation. To account for the huge uncertainty affecting the determination of climate change damages, adaptation costs and effectiveness, the study is completed by an extensive sensitivity analysis, testing results' robustness across different functional parameterization and methodologies for the estimation and aggregation of climate change impacts at the macro regional level.

Findings: The exercise highlights that the main drivers of economic impacts in the EU are those associated to changes in crop yields. At the same time the highest effectiveness of adaptation seems to be associated to the health sector. In general the EU seems to have huge potential to adapt to the climate change impacts considered even though substantive investment is needed. The presence of aggressive mitigation policy does not decrease the need to adapt at least in the first half of the century and becomes more important only toward 2100.

Significance for practical solutions: The analysis is particularly important for long-term climate change policy planning. It shows that, even though there is some substitutability between mitigation and adaptation, both strategies are fundamental. It provides an indication of the potential order of magnitude of investment in adaptation in three key impact areas (health, agriculture, and river flood) with and without internationally coordinated mitigation policies.



ABSSUB-1225

SC 8.3 Population, health and urban land use in integrated climate modelling

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Research question: Long-term population growth is an important driver of population vulnerability to climate change, even in Europe. Despite the importance of this driver, uncertainty around future populations is often poorly characterised in CCIIV modelling frameworks. In this article, the methods and outcomes of integrating population projections within a CCIIV modelling framework at different spatial scales are presented. The options available for population growth modelling, and the choices made at different geographical scales, are presented with details provided on data requirements and technical implementation.

Methodology: With the aim of linking shared socioeconomic pathway (SSP)-specific population projections to a broader CCIIV modelling framework, two approaches, namely a) a probabilistic population model, and b) a downscaling model converting national age-specific projections to the NUTS (Nomenclature of Territorial Units for Statistics) level 2, are contrasted and compared.

Findings: The probabilistic model PEP (Programme for error propagation) is used for selected case studies (e.g. London) to produce a range of possible future projections (up to 2100) of the population structure (via different age groups), life expectancy and heat-related mortality. At a broader geographic scale, a downscaling architecture is designed to incorporate SSP-specific national level population projections to 2100 (Wittgenstein data) as well as Eurostat data (2010) on the distribution of age groups across NUTS 2 regions in Europe. At a pan-European scale, these NUTS 2-scale population and demographic profile predictions are integrated into an urban land use model. Integrated into a CCIIV framework, this urban land use model subsequently supports pan-European health-impact modelling, in addition to other cross-sectoral impact and adaptation modelling.

Significance for practical solutions: The inclusion of a probabilistic methodology enables a more elaborate discussion of uncertainty, critical to a population-sensitive model such as a health model. Equally, the SSP-specific NUTS 2-level population structure is, for the first time, being applied to future urban land-use development scenarios within a CCIIV framework.



ABSSUB-503

SC 8.4 Key findings from the fourth generation of European-wide climate change impact assessments

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Research question: The European Environment Agency (EEA) is mandated to provide timely, relevant and quality-controlled information on the European environment to European, national and sub-national policy-makers in the 33 EEA member countries and 6 cooperating countries, and to the broader public. In September 2016 the EEA will publish its fourth indicator-based report on climate change, impacts and vulnerability (CCIV), following earlier reports in 2004, 2008 and 2012.

Similar to the earlier reports, the 2016 EEA CCIV report presents around 40 quantitative indicators on observed and projected climate change and its impacts, most of them with European-wide coverage. The systems and sectors covered include coastal zones, terrestrial and marine ecosystems, agriculture, forests and forestry, fisheries and aquaculture, human health, energy, transport, and tourism. A key innovation of the 2016 EEA CCIV Report is the inclusion of a systematic review of cross-sectoral climate change impact, risk and vulnerability assessments with relevance for Europe. This assessment aims to answer the question what is known about the risks (and opportunities) from climate change across European regions, and whether findings from different studies using different approaches are largely consistent with each other.

Methodology: This literature review was performed with the active involvement of key stakeholders from relevant research projects, networks and organisations. Particular efforts were targeted at improving the assessment and reporting of uncertainties in observed and projected climate change and its impacts.

Findings: This presentation summarizes the availability of consistent information on observed and projected climate change and its impacts across climate-sensitive sectors and systems in Europe; it also identifies major knowledge gaps.

Significance for practical solutions: Previous EEA CCIV reports have been used as key input to EU and national policy processes, such as the EU Adaptation Strategy (including mainstreaming of adaptation in EU sector policies), national adaptation strategies and plans, and the development of sectoral indicator sets. The 2016 EEA CCIV Report will inform the revision of the EU Adaptation Strategy in 2017, the development of the Copernicus Climate Change Service as well as relevant policy processes at the national and subnational level.



ABSSUB-555

SC 8.4 How do models treat climate change adaptation?

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Research question: Climate change adaptation is a complex human-environmental problem that is framed by the uncertainty in impacts and the adaptation choices available, but also bounded by real-world constraints such as future resource availability and human and institutional capacities. As a consequence, understanding how individuals and society as a whole respond or adapt to the impacts of climate change is critical in evaluating the consequences of future change for human activities and the natural environment. However, though recognised as important, the treatment of adaptation in most climate change impact, adaptation and vulnerability (CCIAV) models is fairly rudimentary, with potential negative consequences for adaptation planning and strategies. In this presentation we explore the research question: How can the treatment of adaptation in CCIAV modelling be improved?

Methodology: Adaptation spans a range of activities from awareness raising to the implementation of adaptation decisions, but within this broad scope, responses can be differentiated along a number of dimensions such as intent or purpose, timescale, spatial scale, beneficiaries and providers, type of action, or sector. We present a typology of adaptation characteristics informed through a literature review and critically evaluate if and how these adaptation characteristics are currently represented in different types of CCIAV models in the land and water sectors.

Findings: We show that the treatment of adaptation is typically modelled in a simplistic, top-down manner, through subjective decisions made by the modeller and considering only a few of the characteristics identified as important. Adaptation is often assumed to be effective, with little account taken of the human decisions underpinning the choice of adaptation measures, the triggers that motivate actions nor the time-lags and constraints that may limit their uptake and effectiveness.

Significance for practical solutions: Based on the insights gained, recommendations are presented on directions for future model development that may enhance their realism while advancing our understanding of the processes and effectiveness of adaptation planning in the face of a changing climate.

ABSSUB-629

SC 8.4 Behavioural models for climate change adaptation in land-based sectors

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Research question: What role can models of human decision-making play in planning adaptation to climate change in land-based sectors?

Methodology: We review models designed to capture human behaviour relevant to climate change mitigation



and adaptation in land-based sectors, and assess the scope and impact of their current usage. We then identify gaps in model design and application, and use a new agent-based model of land use change to investigate adaptive behaviour under a range of scenarios of socio-economic and climatic change in Europe. Finally we evaluate the extent to which behavioural models of this kind have unfulfilled potential in climate change adaptation planning.

Findings: We find that many models have been developed in order to, or with the capability of, simulating adaptive behaviour under climate change. However, most of these models take similar approaches, often involving assumptions about economic rationality, leaving the effects of many important forms of behaviour unexplored. Furthermore, the application of such models to investigate climate change adaptation lags behind technical model development. In our example modelling exercise, we find that behaviour can have substantial impacts on processes and patterns of land use change, particularly where these represent adaptive (or maladaptive) responses to climatic change. For instance, heterogeneity of land managers' behaviour and social influence may have significant impacts on the spatiotemporal effects of institutional action to adapt to climate change. These findings suggest that much can still be learnt, with relatively little further model development, about the potential for successful adaptation in different sectors.

Significance for practical solutions: The practice of adaptation is underpinned by projections of future climate impacts and interactions across land-based and other sectors. In many cases, these projections do not account for real forms of behaviour that may determine the adaptive responses of land managers and other actors. We show that this omission can undermine practical adaptation by generating misleading projections of the feasibility and effects of adaptive actions. We also highlight the scope for addressing this problem with existing modelling techniques, and provide some initial results that indicate practical opportunities and challenges for adaptation in land use.

ABSSUB-997

SC 8.4 Role-playing games in validating agricultural land-use adaptation decisions in an agent-based model

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Research question: One of the major challenges in the agricultural land-use adaptation research is to operationalise the concept of climate change perception in simulating land-use adaptation decisions.

Methodology: Land Use Dynamic Simulator (LUDAS) approach was used as an agent-based model (ABM) to investigate the traditional adaptive strategies in the semi-arid area of Ghana by considering farmers' perception of climate change and variability. To our knowledge, this is the first attempt to assess the role of farmers' perception in changes of land-use adaptation to climate change by using an ABM with the aim of understanding causal links between farmers' behaviour and landscape change. Then, individual and participatory role-playing games (RPG) were used to explore how reliable and adequate was the agricultural land-use system being modelled.

Findings: The simulation results of this research revealed a tendency of subsistence farming in the study area in terms of land-use behaviour and showed a strong implication of climate change perception in the shift among land-use types from traditional cereals farming to the cultivation of groundnuts, maize and soybean.



The findings of the RPG reflect the landscape configuration of the study area, and support the simulation results in the subsistence farming (using traditional cereals) and the use of some cropping systems as agricultural land-use adaptation strategy.

Significance for practical solutions: By isolating a planned adaptation within a large traditional number of autonomous adaptation practices, this research has a merit of contributing to answer the critical question on whether some adaptation practices are stimulated by climate or other factors.

ABSSUB-856

SC 8.4 Protected areas resilient to climate change

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Research question: PARCC West Africa is a project which focused on the impacts of climate change on protected areas (PAs). The project helped countries make their PA networks more resilient to the impacts of climate change, by: 1. Developing innovative science-based tools for assessing the vulnerability of PAs to climate change; 2. Designing adaptation strategies to strengthen the resilience of PAs; and 3. Building capacity in the region for applying the tools and implement the strategies.

Methodology: The project relied on several scientific partners and on a number of innovative scientific methodologies. After developing climate projections for the West Africa region, the vulnerability of species and PAs to climate change was assessed through two complementary methodologies which were later integrated: Species Distribution Models (SDM) and Traits-based Vulnerability Assessments (TVA). An analysis of the connectivity of the West African PA network also highlighted the importance of specific PAs and links between PAs. Based on these findings, systematic conservation planning systems were to help inform conservation priorities in the design of new PAs.

Findings: The following project findings will be presented:

- * The Met Office Hadley Centre provided high resolution baseline and future climate data, as well as regional climate projections; they also studied the future impact of land use change and climate change on ecosystem services.
- * Durham University used models that link species' distributions to biologically important climatic variables that are likely to define species' distributions to assess impacts of climate change on faunal distributions.
- * IUCN Global Species Programme assessed through expert workshops the vulnerability of West African species to climate change based on their biological traits;
- * The potential for combining the two approaches to assess the vulnerability of species was then explored to produce integrated assessments of the potential threat of climate change to species.
- * UNEP-WCMC assessed the connectivity of the protected areas network and identified key protected areas and links between protected areas.
- * The Durrell Institute of Conservation and Ecology (DICE) from the University of Kent carried out a gap analysis and spatial conservation prioritisation for the West African region and the project countries.

Significance for practical solutions: Capacity building took place at multiple levels through national and regional training workshops to ensure that the methodologies developed and the results obtained could be used in country. Based on the scientific results, five pilot sites were selected to implement science-based activities on the ground. Adaptation strategies and policy recommendations were also developed, as well as



practical guidelines for PA managers in the face of climate change. It is now hoped that countries will be able to integrate the project results in their adaptation plans for PA networks, climate adaptation plans, and other relevant national policies.

ABSSUB-247

SC 8.5 Measuring adaptive capacity among local organisations: a case study in south africa

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Research question: Methods for evaluating adaptation projects are a growing concern in both the applied and academic spheres of climate change adaptation (CCA). The key objective of our research is to highlight evidence of how external funding in developing countries is contributing to building adaptive capacity and implementing CCA. The core research question is: what is the role of international funding in building adaptive capacities on the ground? This question will be addressed with a specific focus on local organisations in South Africa.

Methodology: The study is based on a review of existing literature and extensive fieldwork. The programme: "Taking Adaptation to the Ground: A Small Grants Facility for Enabling Local Level Responses to Climate Change" (SGF), funded by the Adaptation Fund and implemented in South Africa, serves as a case study. The SGF aims to empower local organisations to conceive and implement CCA programme. Yet, how do we measure adaptive capacity and track improvements achieved through capacity building process? A literature review served to capture methods to measure adaptive capacities on the ground. Indicators were identified and used to prepare surveys to evaluate adaptive capacities among local organisations. Interviews were conducted with a large number of small organisations identified as potential applicants to the SGF. The goal of the baseline survey was: 1) to assess adaptive capacities among local actors before the SGF starts; and 2) to identify gaps in terms of knowledge and understanding of what CCA is. To track progress in adaptive capacity during the course of the SGF project, surveys are submitted on a regular basis to the SGF grantees.

Findings: This is an ongoing research project. Findings of the baseline survey indicate that adaptive capacities are currently hindered by a lack of operational capacity among small organisations and a limited understanding of CCA, especially its potential contributions to socio-economic development. On the contrary, NGOs working in environmental fields have higher adaptive capacity, reflecting a conception of CCA as an environmental issue only. Building partnerships and training were then identified as critical steps to equip local organisations with the means to implement CCA, including raising awareness of the links between CCA and socio-economic development and strengthening generic capacities.

Significance for practical solutions: This is a collaborative work between researchers and practitioners. So far, results served to inform training sessions offered as part of the SGF. At the end of the project, we expect an increased understanding of what constitutes an effective institutional configuration for CCA in developing regions. Results could then be used to facilitate future scaling up and replication of small grant-financing approaches in South Africa and, potentially, in other developing countries.



ABSSUB-1511

SC 8.5 Learning from stakeholder needs and enabling adaptive capacity: a synthesis from the US West

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Research question: Decision makers in the US Intermountain West and its environs are increasingly concerned with the impact of climate variability and change in their planning for and management of natural resources. The question then emerges, how do information-centric boundary organisations interact within a larger network of organisations and institutions shaping the climate-related decision context for stakeholders?

Methodology: This presentation will synthesize and integrate what has been learned across several research projects over the past 5 years on stakeholder needs, information use, and adaptation progress. It will particularly focus on decision making by federal land managers and municipal officials. We conducted interviews, surveys and mined existing data on expressed stakeholder needs in documents. The area of focus is the US Intermountain West, with a focus on Colorado, Wyoming and Utah.

Findings: The wide diversity of expressed needs demonstrates that there are many needs that extend far beyond information itself. Decision makers in the region have identified a wide variety of needs to help them incorporate climate into their decisions, from improved information, to public education, to changes in legal frameworks – needs which cannot be met by the efforts of a single organisation. And, while decision makers in the region often mention information as a critical need, the context of decision making can also limit the flexibility of actors to incorporate information, make more adaptive decisions or prioritize adaptation in the face of multiple demands.

Significance for practical solutions: The presentation will conclude with inferences about co-production of knowledge, communication, and the structure and function of regional networks and for enabling adaptive capacity.

ABSSUB-1417

SC 8.5 Multi-level perspective for adaptation in Cascais

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Research question: How do different stakeholders at different governance levels perceive and act upon climate change adaptation? What are the main barriers for adaptation? The main opportunities? The main agents? What is the willingness to pay for climate adaptation measures implementation in Cascais?

Methodology: Action-research through 1 online questionnaire (99 valid answers) to the council workforce, 2,000 people street questionnaire to a representative population and 9 participatory workshops with 187 participants from the Municipality of Cascais. He research also included 6 in depth interviews with key political and scientific experts from the Municipality and FFCUL.



Findings: Common obstacles and opportunities are identified; uncertainty is not a barrier for action; political volatility is a barrier; communication between departments and social levels is key; local stakeholders when engage are willing to put their resources for the implementation of adaptation measures and collaborate with local authorities; participation is key for public acceptance and willingness to engage and contribute for the climate agenda; action-research methodologies build social capital and social competences enabling assets to be unblocked and solutions-focused conversations to happen among stakeholders opening new doors and new opportunities.

Significance for practical solutions: Enhance transversal and multi department communication; improve bottom up a top down flows of information; engage citizens and involve local stakeholders; connect with Sustainability and Resilience agenda for better political support; use and maximize the effectiveness of Agenda 21, Mayors Adapt and other political agendas for higher impact on the society.

ABSSUB-1357

SC 8.5 Decision maker preferences for adaptation actions and funding: case studies in Brazil, USA and UK

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Research question: How do social factors and values influence local municipal decision makers and stakeholder preferences for adaptation solutions and funding options? How might these preferences impact local adaptation planning processes and outcomes? The first results of new research from the international METROPOLE project funded by NSF, FAPESP, NERC and ESRC through the Belmont Forum, offers insights into these critical questions.

Methodology: To investigate these questions, our interdisciplinary team developed a process to engage decision makers and key stakeholders in Santos, BR, Selsey, UK and Broward County, FL, US. With local municipal partners, we conducted two, one-day workshops in each community. Our scientists presented information and visualizations which showed infrastructure damage/cost, based on regionally downscaled sea level rise and storm surge data modelled in the COAST tool developed by Merrill et al. To capture participant perspectives, a survey was distributed (and completed) at the beginning of meeting #1. The survey was also distributed at the end of the meeting #2, after presentations and discussions about local risks, adaptation options and cost/benefit analysis. Our questionnaire investigated: 1) value-based attitudes towards governance and environmental change; 2) knowledge of and beliefs about climate change-related risks and priority of action compared to other local problems; 3) preference for adaptation options, and local public finance mechanisms. Demographic data was also collected. The survey was developed with input from our practitioner advisory board, local municipal collaborators and in-country legal and policy experts to ensure the questions reflected local geographic and policy considerations.

Findings: Participants were asked to make judgments about how soon (in time) action should be taken (if at all) on a set of sixteen (16) prototypical adaptation actions that reduce exposure to, or degree of impact of storms, flooding and rising sea level. The research identified patterns in preferences for certain land-use



policies, certain types of nature-based and structural adaptation options, and categories of finance mechanisms. The adaptation actions that were most frequently chosen "now" offered multiple benefits and/or levels of protection, in the present, and the future.

Significance for practical solutions: The research suggests important implications for revising land-use policy, implementing resiliency adaptation options which deliver short and long-term benefits, and for developing local finance mechanisms to support adaptation projects. The findings will inform development of new guidance documents and continuing education programmes for planning professionals and municipal staff through our partnership with the Florida chapter of the American Planning Association and associations in the UK and Brazil.

ABSSUB-1051

SC 8.5 Are we adapting to climate change? The case of Chile, barriers and enablers

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Research question: One of the key messages of the Intergovernmental Panel on Climate Change's (IPCC) most recent report is that efforts have been concentrated on mitigation rather than on adaptation and that key to advancing in adaption is learning from past experiences. Relevant for this learning is a study of what has been done in terms adaptation strategies, plans and practices. Nevertheless, the literature highlights that little research focuses on evaluating adaptation efforts, particularly within Latin America and Caribbean countries. In order to fill this gap, the goal of this study was to investigate the development of climate change adaptation in Chile and the most salient enablers and barriers emerging from these experiences. We evaluated the achievements and the implementation process of the National Action Plan for Climate Change (PANCC) 2008-2012, the first formal instrument created in Chile by the government to guide all sectors in responding to climate change. Our study included the years originally included in the design of the Plan (2008-2012) as well as an extension of the evaluation through 2014 when the process was completed.

Methodology: This study employed an interdisciplinary and multi-method approach, including literature review, document analysis, expert consultation, interviews, on-line surveys, and focus groups.

Findings: The agroforestry sector is identified as the sector accomplishing the greatest and most sustained advance based on the lines of action and specific measures outlined by the PANCC. Results also indicate that greater advances were achieved in adaptation as compared to mitigation, and that the PANCC represents an important contribution towards a national policy and practical response to climate change. However, the evaluation showed that important gaps in this response remain where further progress is required, and that clear opportunities for improvement exist. The most salient of these gaps relates to an absence of adaptive management; the recommendation of the investigating team is, therefore, to incorporate basic principles of adaptive management within national planning instruments such as the PANCC, in order to provide the flexibility necessary to accommodate the uncertainty of climate change, learn lessons from and overcome the barriers emerging during implementation, while maintaining transparency and ensuring a commitment to



public participation. The most important enablers identified include inter-agency collaboration, political will, concern about climate change and communication, while the most important barriers consist of constant change in personnel and institutional setting, limited financial resources, and short-term vision.

Significance for practical solutions: The results presented in this study provide helpful insights that inform theory, policy design, and help fill the knowledge deficit of empirical studies focusing on an evaluation of adaptation efforts in the region.

ABSSUB-1526

SC 8.6 Critical reflections on a co-production science-policy process: a case study from Malawi

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Research question: Attitudes to science and ensuring its effective uptake in policy are changing. There is increasing recognition of the limitations of traditional linear attempts at using science and research outputs to inform policy. This is particularly the case for “wicked problems” such as climate change, which span numerous “traditional” disciplines, have no precedents, and are often characterised by contradictory knowledge. Effectively exploring such issues requires a post-normal approach, where science is rapidly (re) defined and not only informs, but is directed by, policy and decision-making needs. Methodological processes of co-production, where scientists and decision-makers collaboratively define and investigate the issues, are thus also growing in momentum in the science-policy and science-society spheres.

Methodology: Producing and effectively communicating weather and climate information that is timely, tailored, and targeted to decision-makers and their needs – the field known as “climate services” – is often informed by co-production processes. As part of the Future Climate for Africa project “Uncertainty reduction in Models For Understanding development Applications” (UMFULA) we have been engaging in a process of co-production around climate services at national and district level in Malawi. The purpose has been to develop climate scenarios, informed by the needs of decision-makers and innovative science, and test decision-making frameworks, with the ultimate aim of ensuring that weather and climate information can more effectively inform decision-making.

Findings: In this paper we provide a methodological reflection of our initial experiences with co-production. This includes an outline of the process, including (unforeseen) challenges and how they were overcome, as well as insights into the value of the process to the various participants (as opposed to just a focus on the outcome). Early insights highlight the importance of a team with different disciplinary backgrounds who have a commitment to working together and openness to embracing the varied strengths from the different disciplines in an attempt to move forward. At the same time, the ability to effectively communicate outside the science arena is essential – and this often requires flexibility and awareness that a co-production process requires time, effort, and gentle facilitation to gain momentum. Navigating issues of resistance, competing



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agendas, and different expectations for participation can be time-consuming but are essential for subsequent co-production.

Significance for practical solutions: Given the novelty of co-production and the lack of relevant literature, we hope our experiences can stimulate debate and inform the ongoing evolution of co-production methodologies.

ABSSUB-1459

SC 8.6 The co-production of climate-change adaptation indicators at a basin scale: Maipo basin in Chile

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Research question: As the need for climate change adaptation arises so do the practical details about how to successfully implement this adaptation process, given the socio-ecological complexity of systems involved. The Maipo river basin in the semi-arid Central Chile is a generalizable example of the sorts of 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 (e.g., mining, hydropower) and non-productive activities. Future temperature and precipitation changes will result in more stress to this already water-scarce basin. To face the multiple demands in an uncertain future featuring climate change and population increase, public and private sectors as well as civil society will require information and tools to concentrate efforts within the most relevant aspects of life that will need to be adapted.

Methodology: To respond to this need, a three-year project (2012-2015) entitled MAPA (Maipo Adaptation Plan) is being implemented with the objective of identifying both vulnerabilities and adaptation options to potential future scenarios in the basin. Vulnerabilities and potential adaptation options were analyzed and explored with the help of different models of the relationships between the elements in this basin (e.g., water catchment, distribution and use of water). But more importantly, an iterative, collaborative, science-society dialogue was implemented to explore which things the stakeholders value in the basin. This process permits a more effective identification of indicators or performance metrics. Those metrics could justify adaptation options to alleviate the potential impacts of the future scenarios. The iterative science-society dialogue required the assembly of a stakeholder's platform that was named the Scenarios Building Team (SBT). The SBT was convened in the early stages of project development and included representatives from more than 30 public, private and civil society organisations from national, regional and local level. Each of the institutions in the SBT has a governance stake in the management and use of the surface and ground water in the Maipo River basin.

Findings: The result of this collaborative science-society dialogue was the successive definition and refinement of a framework that links water security concepts (beyond water quantity and quality), to the ultimate



societal goals that need to be secured in an adaptation planning. This process resulted in a unified concept that considers water security, ecosystem services, and human well-being.

Significance for practical solutions: This approach facilitates decision-making by framing and highlighting climate change adaptation indicators and adaptation options for the Maipo basin. The process is adaptable to different regions and characteristics and therefore holds potential for use in other regions of the world facing similar forces of climate change and population rise.

ABSSUB-568

SC 8.6 Enhancing the use of indigenous knowledge on climate change mitigation and adaptation in Nigeria

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Research question: Therefore, the goal of this study was to identify, document and learn how to use the indigenous knowledge on climate change in Nigeria, while specific research objectives included: How do we build bridges between formal research areas and priorities in terms of knowledge gaps in adaptation and mitigation policy for local communities and to have empirical evidence for local, state and national advocacy work?

1. How to employ research findings to strategically engage decision-makers at the National and State Houses of Assembly via knowledge sharing workshops on the need to use indigenous knowledge on climate change in policy planning and formulation?
2. How can the assessment of social and economic vulnerability needs help strengthen the processes for identifying adaptation priorities, which could serve National and State Emergency Responses and Mitigation Agencies?
3. How can gathering information on assessment on the use of Indigenous knowledge on climate change be used for policy makers and relevant stakeholders?
4. How can we harness information which will be used to later build adaptive capacity of relevant stakeholders.

Methodology: In this research, four key activities were carried out including : desktop-review, the development and administration of questionnaires; focused group discussions; and direct interviews / field observation. The study was carried out in six selected states in Nigeria (Ekiti, Lagos, Ogun, Osun, Oyo and Ondo).

Findings: The research generated case studies that identified and conserve biodiversity; implement land, water and soil management practices that are based on traditional Indigenous knowledge; help increase the resilience of Indigenous Peoples to climate threats; and innovative adaptation plans and communication strategies based on Indigenous systems that are designed to accelerate learning and knowledge sharing on climate change adaptation.

Significance for practical solutions: The research also identified operational pathways through which indigenous knowledge can contribute to climate change mitigation and adaptation policy goals, highlighting which methods of engagement have proved effective and equitable, and describing some of the common pitfalls of engagement. Ultimately, the objective of this research is to make the experiences of many people available to their brother and sister communities in the hope that the lessons learned by one community can be shared with many, and work to benefit all.



ABSSUB-996

SC 8.6 Comparing robust decision making approaches for long-term water resources in Southern India

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Research question: Deep uncertainty about future climate and socio-economic conditions raises the potential for assess-risk-of-policy approaches over predict-then-act approaches for adaptation decision making. Robust Decision Making (RDM) approaches embody this principle and help evaluate the ability of adaptation options to satisfy stakeholder preferences under wide-ranging future conditions. This study involves the sequential application of two RDM approaches; a qualitative stakeholder-driven approach followed by a quantitative modelling approach, in the Cauvery River Basin in Karnataka (population ~23 million), India. The study aims to (a) determine robust water resources adaptation options for the 2030s and 2050s and (b) compare the usefulness of a qualitative stakeholder-driven approach with a quantitative modelling approach.

Methodology: A combination of climate narratives and socio-economic narratives was used to develop a suite of future scenarios. Using structured expert elicitation with a group of climate experts in the Indian Summer Monsoon, qualitative framing climate narratives were developed for the region. Socio-economic narratives were developed to reflect potential future urban and agricultural water demand. In the qualitative RDM approach, a stakeholder workshop helped elicit key vulnerabilities, water resources adaptation options and performance criteria for evaluating options. During a second workshop, stakeholders discussed and evaluated adaptation options against the performance criteria for a wide range of scenarios of climatic and socio-economic change in the basin. In the quantitative RDM approach, a Water Evaluation And Planning (WEAP) model was driven by precipitation and evapotranspiration data, coherent with the expert-derived climate narratives, together with water demand data based on socio-economic narratives.

Findings: We find that compared to business-as-usual conditions options addressing water demand provide value across a wider range of scenarios and help satisfy legal water supply requirements for downstream riparian states. Large scale infrastructural projects, like inter-basin water transfer also provide value in several scenarios, but their lock-in effects reduces their usefulness in certain scenarios. From a methodological perspective, we find that while the stakeholder-driven approach revealed robust options in a relatively resource-light manner and helped initiate interaction amongst stakeholders, the modelling approach provides complementary quantitative information.

Significance for practical solutions: The study reveals robust adaptation options for this important basin and provides a strong methodological basis for carrying out future studies that support adaptation decision making.



ABSSUB-1311

SC 8.6 Adaptation planning combining participation with novel visualisation and decision support tools

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Research question: Developing urban adaptation plans is challenging due to multi-dimensionality of the problem in terms of stakeholders, sectors, solutions, and uncertainties in time and space. In the case of participatory Climate Resilient Urban Design, other interests such as improving livelihood and mobility are important, too, in particular if funds for climate adaptation are limited. To identify broadly supported, effective solutions or urban designs the Global systems Rapid Assessment tools through Constraint Functional Languages (GRACeFUL) project addresses the following question: Can advanced visualisation, combined with Constraint Functional Languages and Programming improve and speed-up the participation and decision making processes and results of urban adaptation planning and design?

Methodology: Accounting for individual stakeholder preferences and constraints in a transparent and equitable way is a major challenge in participatory processes. Advancing Group Model Building by including and visualizing individual preferences and goal trees will improve transparency. Simultaneously it will provide the required, individual-based, constraints on adaptation measures, which in turn are used as input to identify combinations of acceptable adaptation options by applying constraint programming. Concerning the effectiveness of combinations of options, simple approximation calculations will be applied. Our stakeholder participation and problem explication are supported by an extension of Group Model Building. A domain specific language is developed to bridge between the stakeholder process, the visualisation software and the constraint technology problem solver.

We are developing and testing the tools in collaboration with a case study in the city of Dordrecht, and the Technical University of Delft, in the Netherlands.

Findings: At the time we have developed the conceptual framework that bridges the gap between typical urban adaptation processes and constraint functional programming. By spring 2016 major progress is planned on the development of the tools, the domain specific languages and constraint programming. We will be presenting our findings with respect to the stakeholder process, the visualisations and the link to the problem solving, constraint programming software using the domain specific language.

Significance for practical solutions: Urban adaptation to climate change is a global challenge. Investments in urban infrastructure are mounting as much infrastructure is nearing its end of life. Adaptation needs to be mainstreamed with such investments, avoiding at the least that such investments are increasing climate risk and reduce the solution space. The GRACeFUL work can significantly enhance our ability to develop adequate, supported solutions which can then be mainstreamed in urban investments.

The EU-funded GRACeFUL project is a future and emerging technology project in the field of Global System Sciences.



ABSSUB-957

SC 8.7 Running an adaptation support tool for five years – looking back and forth

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Research question: Decision makers at regional and local level often face major challenges when planning and implementing effective adaptation activities: The available climate scenarios are on long time scales and uncertainties are still inevitable. European and national adaptation strategies can provide an overall framework for action, but they often remain abstract in their meaning for the local decision makers. At the same time, municipalities are facing other, more pressing and more visible problems – like increases in spending for social issues or demographic change.

Methodology: Since 2010, the Federal Environmental Agency in Germany hosts an online-tool called “Klimalotse” for supporting local decision-makers in adapting to climate change. The tool guides organisations to deal with climate change and adaptation systematically: From awareness-raising to interpreting climate information, from the development of adaptation strategies up to implementation and monitoring. Today, the tool is accessed by about 400 visitors per month.

Findings: After five years of successful operation the tool is being reviewed. A research project develops recommendations for a revised version of the Klimalotse. The presentation will give an insight into the key findings of this work. Key findings to be discussed:

- Which climate services are being sought by German municipalities? How are climate services perceived in German municipalities? And specifically, how is the Klimalotse perceived?
- What are the overarching conclusions for the design processes and features of future tools?

Significance for practical solutions: Reviewing and revising an existing tool has great significance for building better future tools. Issues to be addressed here:

- For what purposes are climate services used in practice, particularly the Klimalotse? What were the results of these applications?
- What barriers are central to the implementation of adaptation at local level? How can these be overcome? What are the limits of online tools?
- How can the issues of adaptation be integrated in the local policy making? What can we learn from the actual use of the online-tool?



ABSSUB-685

SC 8.7 Stakeholders should come first: delivering effective adaptation tools with comprehensive engagement.

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Research question: What are the information needs of coastal stakeholders to support adaptation?

What barriers do they face, and are preventing them from adapting? What tools can support them to adapt?

Methodology: We undertook a comprehensive programme of stakeholder engagement throughout Australia to determine the needs of stakeholders, the challenges they face and the tools and information they need to address these. Engagement included several round table workshops with users often lasting several hours, an online survey, and formal meetings with key stakeholder groups. More than 700 stakeholders provided input. They belonged to all levels of government, business and industry, peak bodies and natural resource management groups.

Findings: Products designed to support decision makers manage the risks of climate change are often follow a top down approach of research and development followed by engagement and communication to users. Such tools are generally well designed, based on good science and logical. But in many cases, despite containing information that helps address key challenges in adaptation and supports preparation of adaptation plans and resultant action, have limited support, and are not taken up by and implemented by end-users. Others remain in the domain of their developers, and are used to fulfil contracts and not to ensure that adaptation is effective and leads to outcomes. Most do not address key barriers to climate change adaptation such as lack of leadership, and lack of internal and external engagement amongst others. We present our approach to developing a national adaptation support tool which has been underpinned by significant end-user engagement. We discuss the broad ranging 6-month engagement process (in which we consulted with over 700 people throughout Australia) which we followed to identify needs and challenges prior to the design and development of our products. We provide insights into the needs of stakeholders and in how these needs have been a prime driver of our work. We will share key lessons learned and show how by focussing on the needs of end users we are able to design a tool which can help overcome significant barriers, as well as provide easily accessible technical information, tools and examples to support decision making. We continually monitor the effectiveness of our engagement processes and adjust them accordingly. Our product CoastAdapt, will support decision makers in local government, in business and industry as well as the community to adapt to the challenges of climate change on the Australian coast.

Significance for practical solutions: Only by understanding the needs and challenges of stakeholders before designing, building and developing content, will you be able to design a product that can support their needs. There must be a clear focus on overcoming barriers in the design of any support products otherwise there is a risk that resources and effort will be wasted and adaptation will not be enabled.



ABSSUB-642

SC 8.7 An interactive tool translating complex adaptation information to support policy and decision makers

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Research question: The ToPDAd project has developed an integrated methodology to assess and determine best strategies for businesses and regional governments to adapt to expected medium and long term changes in climate. It is based on an approach integrating sectoral modelling and broader macro-economic assessments with principles from participative and robust decision making. The outcomes are extensive data sets which interpretation requires domain expertise.

To communicate the results of such complex integrated assessments to end users, a flexible interactive tool was developed. The design and development process of an instrument to make outcomes of research projects usable for non-researchers, is typically challenged with many uncertainties regarding the expected research results and the target user groups. However, the valorisation of research results and uptake by stakeholders is increasingly considered an important quality indicator for a project (e.g. Kamateri et al., 2015). Our development approach aims at knowledge that is “fit for use” for policy and decision makers, and supports professionals with specific information needs to explore the data sets.

Methodology: Through interviews with target stakeholders and user groups we determined three main user types (Personas): 1. A policy maker, working in adaptation strategies on a regional level; 2. a business representative seeking information on long term adaptation strategies; 3. researchers (scientific or applied) wanting to investigate underlying data and model outcomes. For each Persona, example scenarios of use were developed. Designs were evaluated using heuristic evaluation and think aloud-method with adaptation experts, focussing on their perspectives of practical decision making. Throughout the iterative process, evaluation results were translated to design and implementation improvements.

Findings: The design approach was applied to set up a decision support tool with as main characteristics:

- (1) a layered approach, allowing users to navigate through the vast amount of available information in a loosely controlled manner from a global to the most detailed level, thus avoiding information overload;
- (2) a form of content and style of communication that does not focus on the (scientific) process but on decision makers demands and the translation of outcomes to a practical decision context;
- (3) a strong emphasis on visuals and visualisation to communicate results through among others a data exploration tool that flexibly adapts to the specific dataset and simplifies its analysis;
- (4) the inclusion of phenomena of specific relevance to adaptation policy and decision making, e.g. dealing with scenario analysis and (deep) uncertainty.

Significance for practical solutions: The followed design approach, its usability principles as well as the developed components of the ToPDAd interactive tool can be used by future initiatives as an example of how to translate scientific expert knowledge to practical material fit for decision makers.



ABSSUB-621

SC 8.7 C-GEAR core: an integrated web cloud tool for climatic risk assessments and decision support

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Research question: A prompt increase in urban development and severe shifts in land use combined with extreme weather events are causing a rapid increase in the vulnerability of the society as a whole. As a result, climate change related risks will rise having as an outcome a heavy toll on life and property. This means that the technologies, systems and institutions are being put to the test by the new climatic demands and environmental loads. In order to achieve a safe and sustainable future, we must safeguard social, environmental and economic systems. Understanding the links between sustainability and climate change is vital to build resilience into communities and society at large.

The changing climate imposes significant threats and can potentially results in setback and losses for business and society. For this reason, we have identified the need for integrated tools that allows the end users and practitioners to make sound decisions, and that can answer the following research question: how to assess the risk of future climate change in a consistent way and what are the adaptation measures that should be implemented timely and adequately?

Methodology: The Climate Change programme at the Strategic Research and Innovation unit of DNV GL has developed the "C-GEAR core" (Climatic Geo-Enhanced Assessment of Risks) climate risk tool. It consists of an engine with a suite of embedded models based on the data specifications. The tool allows the inclusion of up-to-date climate data and proprietary information. All models and databases are closely linked in a web cloud integrated platform (activities ranging from computation to visualization). The developed tool is able to model using reliable methodologies and establishes defined routines for the collection, processing and visualization of spatial and temporal data used for a risk assessment. The risk scale can be defined by the user depending on the resolution and the discretization of the selected features. This is then linked to the several levels of exposure, the physical vulnerability and the probabilities of occurrence of the hazard.

Findings: The "C-GEAR core" consists of three tiers (levels) of computation depending on the amount and quality of the data. The tiers are defined as: 1) qualitative assessment of parameters (heuristic); 2) deterministic assessment (quantitative); 3) Probabilistic approach using Bayesian Networks. This type of approach makes the tool more flexible and able to integrate a broader spectrum of solutions.

Significance for practical solutions: The main practical significance of the "C-GEAR core" tool is that it contains several modules embedded on a web-cloud solution that allows deploying and sharing information to portable devices (smartphones and tablets) internally or externally based on the authorization levels of the organisation. Hinging on this, the "C-GEAR core" also permits the users to enter data through interactive forms while leveraging the power of the web maps and geo-enabled feature services.



ABSSUB-795

SC 8.7 Objectif'Climat: an adaptation planning and monitoring tool developed for French local authorities

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Research question: Local authorities have a central role to play in the multilevel governance of the French National Adaptation Policy. Indeed in France, all cities and authorities larger than 50,000 inhabitants are legally bound to develop local climate change adaptation strategies and action plans. Climate change adaptation requires French local policy-makers and technicians to revisit the way they design and implement public policy in order to better respond in the short-term to longer-term challenges.

Local authorities are now facing a significant methodological challenge that requires adequate analytical and decision support tools to ensure successful mainstreaming of adaptation concerns and measures into their day-to-day planning and operations.

What type of tools and guidelines can help decision makers?

Methodology: The French Environment and Energy Management Agency (ADEME) supports these policy efforts by providing methodological tools and training.

The presentation will provide an overview of the methodological processes proposed by "Objectif'Climat", the reasons why ADEME chose these methods, and why they are particularly suited to climate change adaptation policy.

Findings: One of the main new practices ADEME aims to help develop is adaptive management. The "Objectif'Climat" tool proposes pragmatic guidelines and a planning tool to help structure adaptation action plans, monitor the adaptation process (from vulnerability assessment to the identification of adaptation priorities) and implement evaluation all along the adaptive cycle. The tool proposes a framework for the elaboration of an action plan. It also explains how to construct a monitoring programme based on local indicators to measure the efficiency of the adaptation actions implemented, taking into account adaptive capacities and a comprehensive picture of the territory. Finally, Objectif'Climat provides the local authority with guidance on how to undertake an ex post evaluation of adaptation actions.

Significance for practical solutions: We shall describe how Objectif'Climat aids decision-making by local governments and will share feedback from local authorities that have used the tool and will highlight success factors that can be derived from the French experience of acquiring an adaptive management culture.



ABSSUB-1155

SC 8.8 Towards a (re)conceptualising of maladaptation in policy and practice

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Research question: Despite the potential for climate-related investments and planning to result in negative outcomes, the concept of maladaptation has yet to be fully explored in both conceptual and practical terms. As a result, the term suffers from a lack of consensus regarding its definition and application. Building on recent literature and case study examples we seek to develop a new framework for conceptualising maladaptation in policy and practice.

Methodology: The paper is a conceptual piece that builds on a series of case study evaluations and recent literature regarding the definition and scope of maladaptation in order to present a challenge to current conceptualisations of maladaptation.

Findings: In this paper we highlight a five areas for definitional clarity. First, a conscious decision to not take action should, if contributing to increased climate risks and negative outcomes for people and communities, be considered maladaptation. Second, strategies that do not have a primary focus on climate change should also constitute maladaptation. Third, it is only with time that the success or failure of an intervention will become evident; maladaptation can occur long after a project cycle has completed. One of the principal challenges in evaluation is therefore knowing when to classify a strategy as maladaptive or not. Fourth, assessments of maladaptation therefore need to recognise the complexities associated with shifting baselines and establishing counterfactuals. Lastly, distributional aspects of adaptation need to be recognised in any evaluation of maladaptation.

Using these points of conceptual clarity we present a new framework that distinguishes between two categories of maladaptation, determined by the impacts that adaptation strategies have on climate risk and wellbeing, as well as sub-categories relating to distributional and temporal elements of each. Building on this conceptualisation 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 distinct types of adaptation outcomes.

Significance for practical solutions: We highlight the framework's applicability in assessing strategies that do not explicitly seek to address climate change or are not labelled as adaptation (and hence cannot be considered as maladaptation in the traditional sense of the term). This is particularly relevant when recognising the large potential for development activities to impact (positively or negatively) on people's climate risk, now and into the future. For this reason, we discuss the concept of 'maladaptation-like' outcomes, for which the framework can also be applied. Lastly, we use the framework to highlight a number of different 'symptoms' that can act as early warnings for maladaptive outcomes, hoping to guide policymakers in achieving early diagnosis.



ABSSUB-1152

SC 8.8 Evaluating the priming of adaptation pathways governance in Indonesia

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Research question: Attaining climate compatible development for vulnerable rural communities demands an alternative approach to planning and decision-making based on adaptation pathways principles (e.g. identifying 'no regrets' strategies, decision lifetimes, complex systems thinking). However, this requires existing development planning to transform and apply practices and structures in common with adaptive co-management, which is challenging in developing countries with limited stakeholder capacity and entrenched power dynamics. Using a case study in rural Indonesia, in this study we asked the question 'how can existing development planning processes be transformed to integrate adaptation pathways practice, and how can this process be evaluated?'

Methodology: We conducted a 4-year project which aimed to 'prime' stakeholders in the Indonesian village development planning process to become change agents, and champion adaptation pathways practices. Through capacity-building of an inter-disciplinary Indonesian research team, followed by participatory multi-stakeholder planning processes which applied adaptation pathways principles and tools, we aimed to trigger adaptive co-management (i.e. leadership, trust, co-learning, cross-scale social networks, power sharing and adaptive governance) We also designed a participatory evaluation methodology to track the evolution of adaptive co-management and outcomes in terms of a governance transformation of the Indonesian village planning system.

Findings: The evaluation indicated that the research team became change agents, as did numerous stakeholders at the community and NGO levels as a result of the participatory planning processes and tools. Leadership, trust, cross-scale social networks, knowledge integration, innovation and systems understanding emerged. Numerous innovative adaptation strategies were trialled and adopted by communities, and some were funded by government, NGOs and private sector stakeholders. However, institutional changes within government departments and resourcing of adaptation pathways practice in the planning system did not occur within the project's life due to entrenched centralised planning protocols and vested political interests.

Significance for practical solutions: This study provides three important insights for adaptation pathways practice: 1) our approach to priming stakeholders was effective; however, the immediate influence of change agents was constrained by entrenched government processes and vested interests; 2) policy 'windows of opportunity' and climate or other shocks may therefore be necessary to trigger governance transformation; and 3) because institutional change occurs slowly, projects aiming to generate governance transformation in Indonesia must expect to continue for long periods (i.e. > 4 years). Overall, we suggest that if repeated on a regular basis, our project's participatory evaluation methodology can 're-prime' change agents to seek windows of opportunity for change.



ABSSUB-501

SC 8.8 Envisioning robust climate change adaptation futures for coastal regions

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Research question: The need to integrate various foresight approaches in climate change adaptation planning and future planning increasingly resonates in environmental science and policy arenas. In contrast to forecasting and exploratory scenario approaches, normative scenario approaches like backcasting are the least applied approaches in climate change adaptation planning. The paper investigates the potential of backcasting by presenting a comparative study of three different cases on vision and strategy development for climate change adaptation planning in: (i) The South African Breede–Overberg Catchment, (ii) The Mississippi Estuary–New Orleans region, and (iii) The Dutch Rhine–Meuse Estuary. The objective of the paper is two-fold: to develop a better understanding of such processes, and to further develop the Backcasting–Adaptive Management (BCAM) methodology.

The study addresses whether stakeholder engagement enables implementation and follow-up, whether the guiding and transformative potential of a vision is different in case of multiple or single vision studies, and how multiple pathways support robust climate change adaptation planning.

Methodology: Van der Voorn et al (2012) undertook a first attempt to describe backcasting (BC) and AM as complementary approaches for climate change adaptation and have combined these in the Backcasting Adaptive Management (BCAM) methodology. The BCAM methodology combines the strengths of both approaches, as backcasting provides AM a long time frame for the fulfilment of short and midterm management goals, whereas AM aims to secure adaptiveness within this timeframe.

Findings: Major conclusions based on a cross-case comparison and testing propositions are: (i) participatory vision development is a strong tool for climate change adaptation planning in different governance contexts, and shows considerable diversity in its application in these contexts, (ii) a single, shared future vision is not a prerequisite for vision and pathway development and endorsement, (iii) broad stakeholder engagement enriches strategy development, but the involvement of marginal groups requires additional efforts and capacity building, (iv) multiple pathways and robust elements are useful but require novel expertise, and (v) more institutional embeddedness and support for participatory processes leads to better implementation of the outcomes of these processes.

Significance for practical solutions: The findings have relevance for global climate change adaptation strategy development, which can be downscaled to the regional level:

- Develop a global vision to address global problems and set global goals and targets for inspiring and guiding regional agendas.
- Use multiple visions for goal setting and pathway development.
- Include broad stakeholder engagement for vision and pathway development.
- Develop multiple, long term pathways with robust elements and test pathways against different context scenarios.



ABSSUB-368

SC 8.8 Using sea level rise projections with adaptation pathways in the Torres Strait – a practice case study

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Research question: This is a practitioner case study. The Torres Strait region of Australia is unique with its strong islander community, rich natural and cultural heritage and significant risks arising from sea level rise. While it is considered at a disadvantage due to its remote location, and low economic base, the rich culture, intact environment and strong community gives it the potential to have strong resilience in the face of a changing climate. The challenge was to find a way to effectively communicate the impacts of sea level rise on each community, and work through a diverse range of management options to assist them to make decisions about their future.

Methodology: A comprehensive planning processes was used to identify adaptation options for sea level rise. Adaptation Pathways were used to as a basis of engagement with community leaders and decision makers. Adaptation Pathways usefulness derives from their ability to show how multiple adaptation options relate to each other, and the decision points to choose between the options. The capacity to present the complexity of adaptation options simply, visually and logically makes adaptation pathways a powerful stakeholder engagement and communication tool. Mapping options onto adaptation pathways also highlights missing links and weak points in currently identified responses, thus strengthening the overall planning process.

Findings: Adaptation pathways has proved a useful approach to combine sea level rise projections with local level decision making, to identify an acceptable way forward. Due to the diversity of island types, it was not useful to homogeneously apply sea level rise consequences. The sea level rise adaptation pathways for the region have been calibrated against island specific inundation benchmarks that relates sea level to exposure of critical infrastructure rather than against a projected timeframes. By doing this, the adaptation options can be customised for each island, while allowing diverse adaptation options to be considered by all communities simultaneously.

The visual nature of the Pathways Maps allowed indigenous leaders to engage with the impacts and adaptation options, and were able to make quite difficult decisions about their future. Linking the range of adaptation options to specific island benchmarks allowed the diverse group of regional leaders to discuss the issues of sea level rise as a community, despite the fact that each island had variable impacts over time. It facilitated the development of shared solutions across communities and allowed them to make difficult decisions about their future.

Significance for practical solutions: This work demonstrates that even though some communities face difficult solutions about their future, there are useful and practical tools that allow for effective decision making. Presentation of information using Adaptation Pathways allows for complex and detailed information to be more easily comprehended and discussed by indigenous groups.



ABSSUB-483

SC 8.8 Development pathways as a lens to understand adaptation, maladaptation and maldevelopment

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Research question: Adaptation is being increasingly recognised as necessary to address present and future climate change impacts. In rapidly developing countries, concerns of balancing development aspirations with adaptation investment become critical. Recognizing this, India has attracted large domestic and foreign investments in development and climate change adaptation. However, there has been relatively low debate on the implications of these initiatives on the development trajectories we get locked into, the tradeoffs certain adaptation decisions entail, and whether they address existing vulnerabilities. Against this context, we explore concepts of maladaptation and maldevelopment to demystify whether current development patterns in the country are enhancing or undermining responsiveness to current and future risks. We ask: How can the concepts of maladaptation and maldevelopment be used to critically analyse different development trajectories in India?

Methodology: We undertake an extensive review of the conceptual underpinnings of adaptation, maladaptation, sustainable development, and maldevelopment. Using discourse analysis and key informant interviews, we examine two illustrative development pathways from Karnataka, a predominantly semi-arid state in south India. The first pathway follows the growth trajectory of Bangalore, a primate city in Karnataka that is witnessing high population growth, degradation of its ingenious lake system, rapid real estate development, and increasing inequality. The second developmental pathway examines how agricultural policy in India has shifted from a post-independence socialist approach to the input-intensive Green Revolution phase followed by exposure to global markets through liberalisation, and finally towards climate-smart agriculture in recent years.

Findings: We find that current strategies to manage climatic and non-climatic risks in rural and urban landscapes are undertaken by multiple actors, in multiple ways and at multiple scales. The implications and tradeoffs of development pathways are addressed and experienced differentially across spatio-temporal scales and this is not factored into development and adaptation planning. Maldevelopment (in Bangalore) and maladaptive strategies (in rural Karnataka) have locked rural and urban areas into a restrictive trajectory, resulting in path dependency, risk accumulation, and implications for current and future adaptive action.

Significance for practical solutions: This paper furthers the conceptual understanding of maladaptation and maldevelopment in the context of fast-urbanising countries in the global South such as India, and argues for planning that is cognizant of the implications of present development and adaptation decisions across temporal and spatial scales. We demonstrate that unless adaptation is mainstreamed into development planning, current approaches undertaken in India's cities and rural settlements will lock us into pathways that are unsustainable and potentially maladaptive.



ABSSUB-785

SC 8.9 Climate projections: the missing link of regional and local adaptation processes ?

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Research question: The past periods (roughly until the publication of IPCC AR4 in 2007) corresponded to the awareness-raising of stakeholders on the reality, causes and pace of climate change and on the necessity to act to adapt. The current period corresponds to more applied requests from users: climate data and services are supposed to enable robust decision making in very diversified environments. Issues like uncertainty management (elaborating probabilistic projections based on full ensembles analysis) or tailoring of indicators should be central. However, an assessment of a sample of local, regional and national climate change adaptation strategies, in Europe and in the Med (Stoverinck, Dubois and Amelung, 2013) highlighted the frequent insufficient robustness of climate information used to inform policy making. Some initiatives only refer to past climate data, use only one SRES or RCP scenario, one model or a too limited set of downscaling techniques. Therefore, the spread of results, due to various sources of uncertainties, is not represented, potentially conducting to maladaptation.

The PROCLIM initiative aims at developing a European climate service, proposing territorialized climate projections, supporting local adaptation frameworks, derived from CORDEX.

Methodology: Based on the results of the CORDEX program, we have developed a new tool PROCLIM. The CORDEX program (Coordinated regional climate downscaling experiment, coordinated by WCRP) presented its first results recently. This forms the largest effort of climate downscaling so far. Its datasets, initially developed for scientific purposes, and in particular to support IPCC AR5, have strong potential to improve regional and local adaptation policies. They can be considered as reference for the coming years, not only reflecting the improvement of our knowledge of climate, but also offering data in a much more harmonized and accessible way.

Findings: Working on this CORDEX basis, it encompasses several methodological challenges : understanding local authorities' needs at the European level, specifying indices, selecting relevant geographical domains, correcting systematic biases, selecting sub-ensembles of the CORDEX datasets so as to provide a sound uncertainty analysis, representing results in an user-friendly manner.

Significance for practical solutions: Our presentation will offer an overview of the workflow in PROCLIM and brings experience feedbacks in Jordan to highlight how climate services can play a role in assessing risk and in planning for adaptation.



ABSSUB-1309

SC 8.9 Understanding the value of seasonal climate forecasts for agriculture: a Devon, UK case study

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Research question: A number of methods can be applied to assess the 'value' of climate information in decision-making. However, climate information such as seasonal climate forecasts (SCF) does not have intrinsic value per se as this is acquired through their capacity to influence the decisions made by those using SCF. Hence, the value of SCF is dependent on factors such as the decision-makers activities, how sensitive they are to climate, and the capacity to use SCF. The agriculture sector is extremely susceptible to climate variability and its impacts. As a result, understanding how SCF can be used to help inform decision-making can help farmers to adapt more efficiently and effectively to such changes. However, the use of SCF in Europe is recent and, a result, very little is known about their value for decision-making in the agricultural sector. This study aims to fill this gap by directly engaging with farmers in the Devon region in the UK to explore how SCF can be of value with regards to enhancing their decisions and ability to adapt to climate variability.

Methodology: To assess the value of SCF we worked with farmers in the Devon region in the UK. This study was performed in the wider context of the development of a Land Management Tool prototype as part of the EUPORIAS project (FP7 for research). The aim of this prototype is to develop a working tool for application by farmers in this region. It builds on recent improvements in winter seasonal forecast skill for Northern Europe as well as on-going collaboration with the farmers (n=20) engaged in the development of this prototype. To understand the (potential) value of using SCF in their decision-making, a range of methods has been applied including in-depth interviews and a survey.

Findings: Our study has shown that the diversity and complexity of activities and operations pursued by these farmers translate into a range of different decisions that need to be made during the year. However, despite a lower interest in winter months in terms of agricultural production many farmers recognised the potential for winter SCF to help them plan certain activities such as spreading of slurry and harvesting of winter crops. Preliminary findings point towards the potential value (economic and non-economic benefits) of making SCF available to these farmers in terms of better informed decisions as well as the ability to plan more efficiently and effectively their decisions during winter and thus adapt to climate variability.

Significance for practical solutions: A deeper understanding of the (potential) value of using SCF in decision-making for agriculture can help to improve existing knowledge with regard to the context within which farmers make decisions and how such climate information can enhance their activities. The use of SCF can in turn help to improve their capacity to adapt to climate variability. The findings from this study (and the land management tool prototype developed) can also be generalized to other regions in the UK and potentially beyond.



ABSSUB-1310

SC 8.9 Comparing the decision-relevance of alternative ensembles of climate information

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Research question: What types of climate information are most useful for decision making? How does the utility of climate information depend on the decision context? We know that decisions to manage the risks of climate change hinge, among many other things, on deeply uncertain and imperfect climate projections. Improving the decision relevance and utility of climate projections requires navigating a trade-off between increasing the physical realism of the model (often by improving the spatial resolution) and increasing the representation of decision-relevant uncertainties. This talk will examine the decision-relevance and utility of alternative ensembles of climate information by comparing two decision support applications, in water management and biodiversity perseverance, both in California.

Methodology: Both case studies will use Robust Decision Making (RDM) to conduct the decision support applications in the biodiversity and water supply management sectors. The two decision support applications will cover similar geographic areas, but differ in the sector. We conduct each decision support application with three different climate information experiments, that is different ensembles of climate information. The climate ensembles will consist of different combinations of high and medium resolution projections from NARCCAP (North American Regional Climate Assessment Program) as well as low resolution, but more numerous, projections from the CMIP3 and CMIP5 ensembles. The decision support applications will use the same ensembles of climate projections in different contexts. We will compare both the normative outcomes -- what are the 'best' decisions -- and explore decision maker preferences among the different ensembles of climate information as they are linked to alternative decision outcomes and differing levels of confidence in the underlying information.

Findings: We expect to find significant differences among the two sectors in both the normative and descriptive utility of the differing ensembles of climate information. These results would suggest that utility of different types of climate information depends strongly on the decision context.

Significance for practical solutions: This talk will provide empirical guidance on important questions regarding effective approaches for providing climate information, the types of climate information that might prove most decision-relevant, and how the answers to these questions depend on decision context.



ABSSUB-1284

SC 8.9 The identification of threshold-specific changes in local climate for risk assessment and adaptation

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Research question: Concerns about anthropogenic climate change come with an associated timescale. The most significant changes have been seen since the middle of the 20th century and practical risk assessments stretch forward at most to the end of the 21st century. This places a fundamental limit to the observational data with which changes, particularly at local scales, can be quantified. Similar limits are found when analysing model projections.

Adaptation and resilience planning must usually account for local or regional conditions, and changes therein. Yet even if there is a good observational network over the region of interest, there can only ever be about 90 days in a season and today the historical record is limited to about 65 years for the study of changing climate. Given that climate represents a distribution of weather variables, and that there is inherent natural variability both within and of that distribution, a key question is: what aspects and scales of change in local distributions are potentially identifiable? More specifically, where is it possible to extract robust information about changes at specific thresholds relevant to local adaptation planning and risk assessments?

Methodology: Here we present both a theoretical analysis of this problem and a practical assessment of the consequences for the identification of local changes in temperature and precipitation in Europe. We show how natural variability, both within and of the underlying local climatic distributions, can prevent changes at certain thresholds and locations, being identifiable.

Findings: Such information is of critical importance to avoid the over-interpretation of model projections. Nevertheless, there are many other locations where changes in impact-relevant thresholds are identifiable and sometimes can be very well quantified. These include flooding-relevant aspects of medium-to-intense rainfall in northern Europe, heat-stress-relevant temperatures in many regions including southern England and central northern France, and increasing rainfall in the 10-15mm/day range in Eastern Germany /Western Austria.

This is an ongoing piece of work. By the time of the conference we hope to be able to present results not just for Europe but also for India.

Significance for practical solutions: There are many opportunities to expand this approach to better quantify changes in decision-relevant thresholds in climatic distributions and thereby support the optimisation and prioritisation of adaptation and resilience planning. A key aspect will be close engagement with stakeholder end-users in terms of the quantification of thresholds which impact practical planning; thresholds which will sometimes involve correlations between variables and in time. These opportunities to make better use of scientific datasets to support adaptation, will be discussed.



ABSSUB-1212

SC 8.9 Interactive visualisation of climate impacts, an interactive session

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Research question: *This research focusses on visualisation of this large number of climate impact maps. In an interactive presentation the audience participates in testing of several visualisation techniques. The test results will be available instantly during the presentation and will be used to further improve the visualisation techniques.*

This research focusses on the question *what is the best way to visualise these climate impact maps?*

Communicating climate change information to end users is an important issue in climate science and policy. Climate services are considered to this information to scientists and policy makers. Geospatial climate maps are important and powerful communication tools within these services. These climate maps usually stem from complex climate model runs. Depending on the variables – e.g. climate models, scenarios, time series and probabilities – numerous maps per indicator are generated. Web-based climate portals are popular tools to disclose these maps. However, practical experience has shown that disclosing all maps at once is not contributory to the end users' (scientists, boundary organisations, or policy makers) understanding of the issues at hand.

Methodology: There is not one right way of visualising climate data. The appropriate way to visualise is context dependent. Stakeholder type, type of problem, problem framing, and planning phase all influence the way climate maps should be provided. Within this research different visualisation techniques are introduced that give insight into the broad range within a climate indicator. These techniques can be grouped in static, animated or interactive. The visualisation techniques have been tested on actors involved in municipal adaptation processes.

Findings: Initial results indicate that the interactive visualisations rank highest on accuracy and efficiency. However, this research has not been completed yet. Participants of this session are relevant stakeholders for this research. The audience of this presentation is requested to participate in further testing. A small voting machine will be available for each participant. These machines can be used to answer several questions related to the participants' background and visualisation technique. The results of the participatory part is presented instantly. This part of the presentation is helpful in gathering data on appropriate visualisation techniques for different users in different settings.

Significance for practical solutions: Large investments are made in the generation of more detailed and more comprehensive climate information. Usage of this information at a practical level often lags behind. In this research climate visualisation techniques are explored. By providing insight in climate information to non-experts, usage of climate information will be improved. Participants of this session will be provided with new insights in the visualisation field and helps contribute to further this research.



ABSSUB-858

SC 8.10 Designing adaptation to sea-level rise: Where to protect and where to retreat?

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Research question: Coastal flooding is currently one of the major threats to coastal livelihoods and infrastructure and, due to sea-level rise, flood risk is expected to increase significantly over the 21st century. The two major adaptation strategies against rising flood risk are coastal protection and retreating from the coastal flood plain. While there has been a lot of interest in global scale assessments of increasing coastal flood risk recently, analysis of possible adaptation measures are few in the literature. Moreover, the available studies have focused on protection and not looked at combinations of alternative measures. To our knowledge, the trade-offs and combined effects of protection and retreat have not been assessed before at the global scale. We present such an analysis addressing the question of which combination and timing of strategies is effective and/or cost efficient at the global scale and for selected countries?

Methodology: Our methodology is based on an extension of the DIVA coastal impact model. Protection is assessed based on maintaining and upgrading dikes and retreat based on the policy decision not to upgrade dikes or to install setback zones. Once an area is subject to retreat, we assume that the area is gradually abandoned by the people living there, with population numbers and value of assets decaying exponentially. Under all combinations of measures, we evaluate the impacts of coastal flooding in terms of the expected annual number of people flooded and the expected annual damage costs to infrastructure and buildings. Impacts of retreat decisions are assessed in terms of total number of people to migrate and expected costs of migrating them. Protection is assessed in terms of costs for dike building and maintenance.

Findings: We find that neither protection alone nor retreat alone seems to be an economically efficient strategy to adapt to sea-level rise. Our findings suggest that only between 2 and 32 percent of the world's coastline will be subject to protection with up to 60 million people living today in the retreated coastal flood plains. Costs are lowest for mixed strategies in which retreat is implemented only for coastal areas with low population densities. Retreat, if decided, needs to be done immediately and at a significant level in order to be most efficient. Generally, the longer the time horizon considered is the more efficient retreat options will be, if future impacts are not discounted away.

Significance for practical solutions: The study is of direct practical relevance to national governments of coastal nations around the world, because it is the first study that gives a global overview of the possible combinations of the two major coastal adaptation options. It raises the inconvenient but unavoidable question of where to retreat from the coast. As sea-levels will continue to rise for centuries even if greenhouse gas emissions would stop today, which has been termed commitment of sea-level rise such decisions are unavoidable on the longer run for all coastal nations.



ABSSUB-1034

SC 8.10 An integrated framework to analyse vulnerability and adaptive capacity to sea level rise in Brazil

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Research question: Coastal zones face significant environmental and socio-economic impacts that is already experiencing extreme events. Increased frequency of intense storms events and along with the rise in sea level, lo leads to more coastal flooding. It is extremely important to improve and create tools that allow stakeholders to access reliable science-based information to help them respond to the risks of climate change and sea level raise impacts and assess opportunities for adaptation in coastal areas.

Methodology: The location for Brazil is the city of Santos, which is the main port of Brazil. The METROPOLE project is funded by BELMONT Forum. The hypothesis of the project is that risk knowledge is best understood as being co-produced by science and by the social, political and cultural context, engaging stakeholders and policymakers in participatory planning meetings to analyse the social and cultural factors that impact decision-making and regional adaptive capacity. The COastal Adaptation to Sea level rise Tool (COAST) is software that models flooding damage to assets from storm surge and sea level rise over time. It can calculate one-time damages from a single event in time; as well as cumulative damage from all possible storms over a given time period. It then is used to calculate the benefits and costs from various adaptation strategies to determine which strategy is the most fiscal economically efficient over time. A one hundred year storm surge is the height of water with a probability of 0.01.

Findings: For Southeast Zone, the damages from storm surge increase greatly from an SLR of 18 cm to 45 cm, and even more for the 1.00 m. with SLR between 18 and 30 cm damages by 2050 are concentrated along the Ponta da Praia neighbourhood. By 2100, Between 30 cm and 1 m the damaged area extends along the coast extending the flooding and storm surges few blocks away from the coast. By 2100, for 1 m SLR, if action is not taken, several areas in Ponta da Praia would be lost due to permanent inundation by SLR. For the Northeast Zone, large areas with high tides due to SLR in the section along the main canal with SLR of 18 to 30 cm, covering a large region and a SLR of 1 m the area flooded can extend until the over most of the region. The estimated damages concentrate mainly along the canal and along the coastal line, with the damages more concentrated (building lost due to flood) mainly in the Sao Manoel region. The cumulative damages shows higher losses for the Southeast zone of Santos, with cumulative losses of \$R 1.7 billion with a SLR of 1 m between 2010 and 2100, while the Northwest zone shows losses of \$R 550 million.

Significance for practical solutions: We show the results of the applications of COAST in Santos, assuming various sea level rise levels until 2100. The partnership with the municipal governments will facilitate the internalization of the results and the implementation of public policies and appropriate environmental legislation and allowing the municipals to better manage their coastal areas.



ABSSUB-1018

SC 8.10 Storm surge inundation risk analysis for coastal electricity generation facilities

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Research question: This research explores two different research questions associated with the future risks of coastal hazards to electricity generation facilities in the eastern United States. The first question is how do uncertainties in biophysical and socioeconomic factors interact to affect risk. The second question is what is the benefit/cost ratio of enhanced coastal defences for such facilities, and how does that ratio vary over different time scales.

Methodology: The research applies a probabilistic tropical cyclone storm surge inundation model to generate high-resolution (10 meter) maps of inundation depths for the U.S. mid-Atlantic region. Inundation modelling was conducted assuming current sea level as well as a time series of future sea-level rise based on the Representative Concentration Pathways (RCPs). Inundation modelling was used to construct probabilistic distributions of inundation depths for 25 electricity generation facilities vulnerable to coastal inundation. Monte Carlo methods were used to integrate the likelihood of inundation with information on tropical cyclone probabilities, facility damage functions, facility replacement costs, facility depreciation rates, and discount rates to enable risk analysis for economic losses due to storm events. Adaptation in the form of flood levees of varying heights and the costs and benefits of levy construction in future years were also incorporated into the model.

Findings: Despite all facilities have the potential to experience some degree of exposure to storm surge inundation, inundation depth distributions varied significantly among facilities as did projected economic damages. Damages were particularly sensitive to both the inundation depth and the capital cost of the facility at risk. For most facilities, benefit/cost ratios of levy construction were generally greater than 1, particularly for levees of modest height. Benefit/cost ratios increased markedly with delays in construction, because benefits of levy construction are lower over the near-term relative to the long-term.

Significance for practical solutions: This research presents a methodology for practical risk analysis and cost/benefit analysis for critical infrastructure that also accounts for key uncertainties in decision-making. In addition, the research suggests that decision-makers may benefit from delaying investments in adaptation depending on their relative preference for type-I and type-II decision errors.



ABSSUB-1275

SC 8.10 Spatially-explicit coastal flood impact scenarios for sea-level rise adaptation

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Research question: Coastal cities across the world are facing increasing coastal flood risk owing to sea-level rise, changing storm activities associated with changing climate, increasing coastal population and asset density, and local subsidence. There is now a pressing need for adaptation to reduce future exposure and vulnerability. While sea-level rise adaptation planning often considers timeframes as far as year 2050 and 2100 that are used in climate projections, the associated socio-economic impact of sea-level rise estimated at those timeframes are highly uncertain given the limitations of climate models and uncertainties in long term future changes in social factors such as population and infrastructure. In this light, sea-level rise adaptation strategies developed based on a single prediction of the potential socio-economic impacts are unlikely to succeed. Therefore recent research suggests that a broad range of future scenarios of physical and social changes should be considered in adaptation planning to account for more uncertainty. But how can a large number of scenarios be considered in sea-level rise adaptation planning without overwhelming the decision-makers? If a method is developed, whether and how it may influence the decision-maker's understanding of the problem and the adaptation decision-making process?

Methodology: This research develops a neural network-based method to identify a discrete set of coastal flooding impact patterns that are robust across multiple future scenarios. Given that spatial distribution of impacts are important in understanding how impacts cascade through networks and in prioritizing resources and efforts, the impact patterns are spatially explicit. To demonstrate and evaluate this method, it is applied to the City of Vancouver, British Columbia, Canada, to identify robust patterns of economic (e.g., business disruption) and social impacts (e.g., vulnerable population affected) associated with multiple scenarios of coastal flooding and sea-level rise.

Findings: Spatially-explicit patterns of economic and social impacts associated with a large number of coastal flooding scenarios in the City of Vancouver will be presented. Responses from City of Vancouver's stakeholders regarding the utility of these impact patterns will also be discussed.

Significance for practical solutions: This sea-level rise impact assessment method allow decision-makers to consider impacts that are cross-cutting through a large number of future scenarios rather than individual scenarios. Relatedly strategies developed to address such robust impacts can be more uncertainty-tolerant than those designed to address a single projected future.



ABSSUB-809

SC 8.10 Timing of adaptation to high end sea level rise: when to start?

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Research question: Adaptation is essential to reduce the impacts of coastal climate change, as due to the commitment to sea-level rise, climate mitigation has limited immediate benefits. Financing climate change adaptation must be undertaken wisely so as to maximise physical, social and economic benefits in a timely manner and to ensure those most at risk are afforded protection. This is particularly so for high-end sea-level rise as alternative forms of protection (e.g. barriers across lagoons or estuaries, such as MOSE, Venice or the Thames Barrier protecting London) may need to be considered which are more expensive than those protection options used today, or need a greater planning time frame to reduce costs. Given the large uncertainty in the rate of rise, most particularly in the melting of large ice sheets, a further challenge is to determine what level of adaptation is appropriate. Thus, this research analyses the financial costs of sea-level rise, and considers the timing of global protection costs throughout the 21st century, as to ascertain when is best to adapt.

Methodology: Damage and adaptation costs have been determined using the Dynamic Interactive Vulnerability Assessment (DIVA) model for three high-end scenarios of sea-level rise (with 1.0, 1.3 and 2.0m of sea-level rise by 2100) and five socio-economic scenarios (Shared Socio-economic Pathways 1-5). Results are reported at global level, as well as for World Bank regions throughout the 21st century.

Findings: Initial results project global damage costs without further adaptation as between US\$8 billion / year to US\$51 billion / year in 2100 for rises of 1m to 2m for SSP1-5. Low income countries report particularly high damage costs that increase throughout time. If adaptation is applied in the model, residual damage costs for low income countries are high in 2030s, but significantly decrease in the second half of the 20th century. Thus, adaptation is a cost-effective long-term investment.

Significance for practical solutions: These results suggest there is a spending choice where policy guidance and practical solutions need to be strengthened: Spend now to adapt low income countries to high-end sea-level rise in order to reduce costs in the second half of the century, or experience similar costs in terms of damage after 2050. Greater engagement and practical solutions are required to integrate climate change adaptation into existing infrastructure needs. This could mean engineering less conventional strategies of protection, including nature based solutions, managed retreat or accommodation via rising infrastructure.



ABSSUB-1172

SC 8.11 How is adaptation, resilience, and vulnerability research engaging with gender?

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Research question: The gendered dimensions of climate change have received increasing interest in climate change adaptation, resilience, and vulnerability (ARV) research. Yet concerns have been expressed that engagement with 'gender' in this work has been tokenistic. In this context, we ask: how is climate change ARV research engaging with gender?

Methodology: To determine the ways in which ARV research is engaging with gender, we developed a conceptual model capturing attributes of 'engagement.' The conceptual model has three attributes, gender mainstreaming, the experience of gender, and the degree of action, which capture how gender is incorporated in a study. An assessment rubric based on a series of standardized indicators was then designed to operationalize the conceptual model to examine the level of gender engagement in ARV research. This model and rubric were applied using a systematic literature review methodology in order to identify relevant articles and ensure comprehensiveness.

Findings: Results indicate an increase in ARV studies with a gender focus over this period, with the level of gender engagement also increasing. There are a relatively equal numbers of studies categorized as engaging gender at a high, medium, and low level, with studies from Sub-Saharan Africa consistently exhibiting high levels of gender engagement. Gender focused ARV has a strong focus on examining female experiences, with few studies explicitly focusing on men, and no work accounting for those identifying outside the gender binary. In the literature focusing on women, two framings were generally discernible, with women either being described in a passive manner as a vulnerable sub-population or viewed as active participants in responding to climate change impacts. The majority of these articles described women as vulnerable, yet rarely examined the causal processes making women more vulnerable, overlooked the agency of women in responding to climate impacts, and failed to examine the barriers that need to be overcome to reduce vulnerability.

Significance for practical solutions: This research provides a baseline understanding of to what extent ARV research is engaging with gender concepts. By charting the landscape of ARV's relationship with gender since 2006 this work clearly highlights key gender concepts that ARV researchers should consider if they want to ensure their research is inclusive and engaging with concepts of gender at a high level. We highlight the pervasive, yet oft unexamined, narrative that women are vulnerable and urge future ARV researchers to critically examine how they may be reproducing this narrative, to the detriment of ARV planning and assessments, in their own research.





ABSSUB-927

SC 8.11 To study variance in adaptive capacities of women from different social groups in SAR of Maharashtra

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Research question: How do adaptive practices of women belonging to different social groups to deal with climatic and non-climatic factors vary?

Justification: Vulnerability to climate change varies across social groups as well as within them. It is determined by the difference in their coping ability and access to resources required to manage the existing and future climate and non-climate risks. These determinants are further shaped by social, economic, cultural, political, and institutional factors. Degree of exposures of women and men within these social groups and their adaptive mechanisms to manage these risks are influenced by ascribed gender roles and relations in society. This paper aims to understand the differential vulnerabilities of women within various socio-economic groups with respect to their adaptive capacities to deal with the climate and non-climate risks they are exposed to. The findings of the study enabled the delineation of coping/adaptive practices carried out by men and women thus reflecting the variance in such practices for women belonging to these groups.

Methodology: Study area:

The study is conducted in the rural semi-arid regions of Sangamner block of Maharashtra.

Data collection:

- 1) **Community Driven Vulnerability Evaluation - Programme Designer (CoDrIVE-PD)** - The data is collected and assessed using the tool Community Driven Vulnerability Evaluation- Programme Designer (CoDrIVE-PD). The CoDrIVE-PD is a tool developed by WOTR to conduct vulnerability assessments which helps make a precise assessment of the Who, What and Why of the climate risk (vulnerability).
- 2) **Stakeholder Engagement** - Under the ASSAR research project, stakeholder engagement events were conducted with local communities during which adaptive practices outlined with the help of CoDrIVE-PD were analysed in depth.

Above tools will be used to collect data from the following landholding groups and castes within them:

- 1) Large land owners
- 2) Medium land owners
- 3) Small and Marginal land owners
- 4) Landless

Findings:

- 1) The study brought out the various climatic and non-climatic risks that the communities are exposed to and their impacts.
- 2) The study brought out the adaptive practices of women from the different groups and the reasons for the observed differences. For instance during dry spells, women from small and marginal farmer groups, migrate daily to neighbouring villages in search of agri-labor, while women from large farmer groups, are relatively well off in terms of irrigation infrastructure.

Significance for practical solutions: The study has helped us identify maladaptive and good adaptive practices, therefore, allowing us to recommend strategies to promote enhance the resilience of natural resource base and communities.



ABSSUB-541

SC 8.11 Climate change adaptation policies and practices in the delta region of Bangladesh

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Research question: This study investigates the focus of adaptation policies and practices for a developing but proactive country like Bangladesh especially in its delta which is extremely vulnerable to climate change.

Methodology: The first step in the policy review was to identify relevant policy documents that reflect the government's approach to climate change adaptation. The aim was to investigate if climate change adaptation is acknowledged within each policy/plan at the national level of Bangladesh. Then the policy analysis investigated the adaptation options presented in each policy/plan.

An inventory of adaptation practices in the delta of Bangladesh was prepared. Currently observed and documented adaptations were within the purview of the protocol. Published literature – both peer-reviewed and grey – was collated in a universal spreadsheet template. The template had 43 columns recording inter alia the purposefulness, geographic location, sector, provider/beneficiary, historic evidence, timing, stresses and drivers, barriers to participation, gender issues, link to migration, current and future damaging aspects, function/effect and long term sustainability of the adaptation practices.

Findings: A total of 22 climate change related policies have been reviewed. It has been found that climate change adaptation terms have started proliferating since 2000 especially after cyclones Sidr (2007) and Aila (2009). In the policies, the climate change issues are more focused on disaster risk reduction. There is very little focus on urban issues although the country is being rapidly urbanised. Ecosystem based adaptation and community based adaptation have just started emerging in the policy documents. Out migration is treated as a valid climate change adaptation option.

A total of 83 physical-infrastructure-technological (PIT) and 71 socio-economic (SE) adaptation practices were identified for the delta within Bangladesh. The maximum number of PIT adaptation practices was found in the water resources management sector while that of socio-economic practices occurred mostly in agricultural sector, in both cases with about one-third of total practices. PIT practices were found to be mostly anticipatory in nature whereas SE practices are mostly reactive.

Six thematic areas namely, food security, disaster management, infrastructure, research, mitigation and capacity development are the focus areas of intervention of Bangladesh Climate Change Strategy and Action Plan. It was found that most of the adopted practices belong to infrastructure and then food security category. Very little practices were found in research and capacity development.

Significance for practical solutions: The study shows the preferences of a developing country in managing its climate change risk. It shows that infrastructure development and food security are key issues for Bangladesh. Most likely, similar picture will emerge in other developing countries. This gives a direction towards better utilization of adaptation funds being proposed in COP21.



ABSSUB-1279

SC 8.11 Examining the suitability of 'subjective' forms of resilience measurement: insights from Tanzania

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Research question: So far, efforts to measure a household's resilience to climate change or disaster risk have largely focused on the use of 'objective' frameworks and methods of indicator selection. These typically depend on a range of observable socioeconomic variables, such as levels of income, the extent of a household's social capital or its access to social safety nets. Yet, while objective methods have their uses, they suffer from well-documented weaknesses.

This paper explores the use of an alternative and complementary method: the measurement of 'subjective' resilience at the household level. Subjective household resilience, relates to an individual's cognitive and affective self-evaluation of their household's capabilities and capacities in responding to risk. In particular we explore the practicalities, feasibility and suitability of a subjective approaches through analysing the results of a national survey in Tanzania.

Methodology: The paper draws on the results of a nationally representative household survey (n=2200) in Tanzania designed to explore subjective evaluations of a household's capacity to deal with flood risk. Using various statistical tests and predictive modelling we examine the relationship between perceived levels of resilience and various socio-economic characteristics. These are then compared with drivers traditionally associated with resilience and findings from objective methods of resilience assessment.

Findings: Findings from the Tanzanian survey showcase a range of interesting features. Factors such as level of education, livelihood, and age demonstrate some effect on people's perceived resilience, but relationships are not as strong as expected. Other factors, like gender, have no apparent impact on evaluations of household resilience, even among female-headed households (typically considered to be one of the most vulnerable groups). Unsurprisingly, the strongest predictor of resilience is wealth and level of income. Of particular interest is that those who received early warning information relating to prior floods rated themselves as considerably more resilient than those who hadn't, suggesting that support for the dissemination of weather forecasts and alerts in east Africa may be having an effect on perceived levels of resilience.

Significance for practical solutions: If shown to be effective, subjective household resilience could be used to improve policy and decision making, through the evaluation and targeting of resilience-building activities, national and international resilience measurement, and the inclusion of bottom-up perspectives in decision-making processes at various levels of governance.

Most importantly, subjective resilience assessment has the potential to change the way that we track resilience and hold governments and civil society to account. It allows for a bottom-up way of judging the effectiveness of resilience-building initiatives based on the perspectives of the people that matter most: those who are vulnerable and receiving support.



ABSSUB-740

SC 8.12 Advances in guidance standards for adaptation planning

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Research question: In recent years a plethora of adaptation planning guides have been produced, many based on the underpinning adaptive management framework enunciated by the UK Climate Impacts Program (2003). Have these captured recent advances in adaptation thinking to the best effect for planners?

Methodology: In preparation for producing an updated guide for Australia, we reviewed the common features of over 30 of these recent guides, as well as other advances in the literature and practice.

Findings: We identify key features that are so consistent that all guides should contain them or explain why not. We also identify a series of recent advances in adaptation planning that are not reflected in many guides but which theory and practice show are valuable. These include a much greater emphasis on context analysis and methods for this; better definition of how to identify adaptation measures and options; clarification of the methods for appraising among adaptation options; and some further guidance on implementation and monitoring. Most importantly, we find that examples of applied adaptation planning are diverse but can be captured in three general cycles for any organisation, region or sector – a Scan cycle that identifies general areas of decision making where there are risks and adaptation opportunities that require more detailed attention; a Portfolio cycle that leads to relative priorities across that set of decision areas; and a Project cycle that helps implement the specific investments needed in relation to one area of decision-making.

Significance for practical solutions: This simple classification leads to a surprising number of insights about how planners should emphasise different issues in the individual steps of different adaptation planning cycles, including: when diagnostics of social and institutional barriers should be emphasised; how much climate data of what sorts should be sought; how complex the process of appraising adaptation options should be; and other systematic improvements in the specific advice to users. This paper will summarise these findings as tested with users, and frame the proposed Australian guide.

ABSSUB-1202

SC 8.12 Demand vs. supply of adaptation support in Nepal: what factors drive to the sustainability?

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Research question: Nepal has been planning and implementing adaptation projects at the local government and community forests user groups (CFUGs) level with the engagement of multiple agencies to enhance community resiliency. This research interrogates how have adaptation supports been providing at the local level and how vulnerable communities have responded those support mechanisms? It also assesses what approach drives balance and sustainability of demand and supply adaptation supports?

Methodology: This research is based on the existing adaptation policy and framework analysis, observation of support mechanism to prepare and implement local adaptation plan of action (LAPA) and community adaptation plan (CAP) by different agencies specially the Multi-Stakeholder Forestry Programme (MSFP) as



a case, seven expert interviews at the national and local level, field observation in three MSFP implementing districts, literature review, and authors' years long research and programme implementation experience on climate change adaptation.

Findings: This research found that the science based awareness activities are more supply driven and been implemented with the interest of supporting agencies though some adaptation interventions have already been practicing utilizing local indigenous knowledge. LAPAs at the local government level are more supply driven mostly imposed by government policies and frameworks while CAPs at CFUGs level are more demand driven by vulnerable communities. However, some urgent adaptation activities including conservation of water holes, and forests conservation are mostly demand driven.

Adaptation planning and implementation is observed more demand driven in CFUGs while employing integrated, participatory, and bottom-up approach. Similarly, CFUGs, the autonomous and resourceful local institution, were more active on adaptation plan implementation with the ownership of local communities and even by allocating their fund on it. We argue that adaptation planning and implementation ensuring 'meaningful' participation of vulnerable communities with integrated and bottom-up approach could drive demand based adaptation supports. The sustainability of adaptation projects and support to more vulnerable communities could be expedited while utilized CFUGs practicing well-established equitable benefit sharing mechanism.

Significance for practical solutions: This research offers knowledge contribution on potential options to balance between supply and demand on adaptation planning and implementation support at the local level. Employing integrated, participatory, and bottom-up adaptation planning and implementation approach recognizing role of local institutions could increase local ownership and ensure effective implementation.

ABSSUB-548

SC 8.12 Base: adaptation in Europe from a bottom-up and top-down perspective

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Research question: How to assess the full cost-benefit of adaptation in Europe? A series of comparable case studies were designed to elucidate the question.

Methodology: The key thinking and methods behind the FP7 project BASE will be presented. Comparable case studies across sectors and across Europe is at the core of BASE. These will address the full cost-benefit of adaptation from the bottom-up. We applied a suite of sector specific models in a rigorous case design. The results from these case-studies and process analyses are subsequently upscaled in a pan-European model the Adaptation World Induced Technical Change Hybrid (AD-WITCH) model to provide a refined analysis of the full costs and benefit of adaptation. The project moreover applied novel case-studies methods in terms of comparability, the thinking behind and the core methods will be described.

Findings: We developed a rigorous design for the case studies and applied the same assessments, methods, and models in all clustered cases among the more than 25 cases in total. We assessed the role of economic instruments and approaches in the cases applied by the case study holders (e.g. city officials; water managers and others), as well as the methods to assess non-monetary values by them to involve local stakeholders to assess the level of participation and co-creation of adaptation solutions to ensure both robustness and



empowerment. We assessed how to, as well as the limitation in translating these multi criteria to monetary values. The results were then reflected upon the EU sectorial policies and guidance was provided on how to improve the resiliency of Europe and how to optimize the implementation of the EU Adaptation Strategy in a sustainable manner.

Significance for practical solutions: The case study results tell for the first time ever the story of replicate adaptation case studies in the world. Secondly, the importance of the cost analyses and the participatory analyses and method description is developed the wider global adaptation community in mind as well as the Climate-ADAPT portal, by providing examples of next practices. Lastly, the BASE project organised and hosted the Second European Climate Change Adaptation (ECCA2015), which brought together academics, policy, practitioners and industry – lessons learned from this will also be shared.

ABSSUB-952

SC 8.12 Redundancy, an urban design tool to measure passive survivability: Caribbean experience

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Research question: How can better design of urban form enhance its resilience to extreme climatic events? What urban design tool can be used to measure and monitor such resilience and how?

Urban areas represent the complex intersection of and interdependency among bio-physical agents, human systems, and urban infrastructure and are vulnerable particularly to rapid-onset climatic events (e.g., hurricanes). During and immediate after such events, urban people face the most critical period to survive passively, perhaps without having basic infrastructural services, e.g., power or water supply. For example, in Chicago a 1995 heat wave killed more than 700 people who lacked air conditioning, and in eastern Canada, a massive 1998 ice storm left 4 million people without power and forced over 600,000 from their homes. The extent of this passive survivability depends on built environment's inherent resilience and its ability to offer critical life-support conditions for its users for an extended period-up to 2 to 7 days. Urban resilience literature has included several aspects including disaster risk management and long-term coping strategies but overlooked passive survivability. By addressing this shortcoming, this research considers redundancy-a socio-ecological concept, analogues to superfluity, excessive, and abounding too much-as an urban design tool to measure and monitor urban resilience in the context of Negril, a coastal area in Jamaica vulnerable to climate change.

Methodology: This study considered urban morphology that encompasses street networks, blocks, building footprints, and land use patterns to develop a design framework that clarifies Negril's typology of built environment. To operationalise the framework, the study used direct observation and interviewed 19 planning and design professionals of different agencies, responsible for climate change adaptation in Jamaica.

Findings: Negril's entire settlement, particularly Long Bay's one, depends on a single street and livelihood, thereby exhibiting limited redundancy. Local professionals are also aware of redundancy as it spreads risk across areas and time, and consider both built and natural systems to increase resilience. Improving multiple connectivity and networks between buildings and major public spaces would increase redundancy while simultaneously strengthening evacuation process that could reduce the time of critical survivability. Such multiple networks would also promote Negril's economic activities. However, couple respondents argued that



the use of additional resources is often associated with redundancy. Thus, the optimal level of redundancy and diversity-determined locally-is essential to balance between enhancing inherent resilience of a given area and meeting the sustainable development goals established recently in a UN conference.

Significance for practical solutions: The proposed framework offers a set of design guidelines for Caribbean future coastal developments and establishes theoretical links among resilience, adaptation, and urban design.

ABSSUB-1179

SC 8.12 Tef production in Ethiopia: when what we like is more important than what works

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Research question: Tef (*Eragrostis tef*) is a minute-grained cereal that occupies about 65% of agricultural land in Ethiopia. Historically, this minute grain was favored by the feudal royal families which ruled over Ethiopia, while the majority of mainstream population depended on other crops. Because of this history, tef has got a privileged position as a national dish in the form of flat bread called *Injera*. Currently it has become the main food of the bulging urban middle class in the country. As Ethiopia is one of the countries where food security has been on everybody's agenda for decades, we hypothesized that tef based farming system, occupying vast majority of the country's fertile agricultural land, has been contributing towards the problem.

Methodology: We conducted a survey on farmers' preferences, inputs, labour demand, fertilization and market drivers in major tef producing regions of the country. Measurement of yield and yield parameters were made under farmer and experimental stations conditions. Data on nutrition and straw quality for animal feed were obtained from secondary sources. We compared our results with wheat based farming system, as the two crops have similar agro ecological requirements (using nutrient equivalent/ha, not actual yield in tons/ha). We also used simulation models to predict expected changes in tef productivity in the face of climate change.

Findings: We found that tef production requires more water, labour, fertilizer and creates more ecological foot print than Wheat. We also found that the nutrient equivalent/ha yield of tef is significantly lower than that of wheat under the same condition. Simulation analysis showed that tef will face up to 100% yield loss as a result of predicted increase in rainfall during December when tef matures, because of its high rate of shattering under rainfall at maturity. From another simulation result, we found that allocating just 10% of resources currently used for tef production to wheat production, there would be a 25% boost in the country's cereal self-sufficiency.

Significance for practical solutions: This study indicated that the current practice of tef production cannot be sustainable. To improve food security problems that is inevitable to challenge tef producing farmers under the face of climate change, research on cultivars that adapt more, policies that modify the systems and alternatives in the case of severe impacts is needed.





ABSSUB-1523

SC 8.13 Development of 'profitable' climate adaptation for built assets

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Research question: The research questions include:

- (1) How could 'profitable' or economically viable climate adaptation policies be achieved by well-informed decision-making for long-service-life built assets at a national or regional scale?
- (2) How would the 'profitability' of climate adaptation at a regional scale depend on the timing of its implementation?
- (3) How would the 'profitability' of climate adaptation at a regional scale be related to its planning horizon and spatiality?

Methodology: This paper presents a statistical approach to investigate the feasibility to develop 'profitable' climate adaptation by understanding the future direct damage loss and the benefit of adaptation, for example, through the changes in design and planning of buildings affected by storm-tide hazard and sea-level rise or strong winds in Australia. Policy stances to take reactive, pre-emptive or business-as-usual approaches will be considered to test the benefit to implement climate adaptation at national scale. More specific assessment of the profitability to implement climate adaptation by design changes in Southeast Queensland, the fastest growing region in Australia in the last two decades, will be applied to illustrate the fact that the profitability closely depends on implementation timing, and especially policy horizons.

Findings: The profitability closely depends on implementation timing, and especially policy horizons. It is found that with limited adaptation, immediate but less long-term profitability could be achieved by focusing adaptation on the most vulnerable built assets, while lack-of-profitability for wider adaptation in short-term could be approved to be more profitable in a long term. The assessment also indicates that the long-term loss could happen if there is too much over-adaptation with unreasonably high initial and on-going costs while the benefits could only be achieved over unrealistically long period.

Significance for practical solutions: Considering the service life of build asset are normally lasting more than four decades for residential buildings and more than ten decades for critical infrastructure such as road and bridges, it is critical to consider climate adaptation into their design and management. However, the viability of climate adaption is largely subject to its benefits and the associated costs as a result of climate adaptation implementation. This would particularly become complex when it is highly subject to the uncertainties, not just in future climates, but also in socio-economic trends. The study provides a solid foundation for better adaptation development that is economically viable for different adaptation planning horizons.



ABSSUB-631

SC 8.13 Long term investment scenarios and an opportunity to collaborate

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Research question: What are the future costs and benefits of managing flood and coastal erosion risk in England in a range of different scenarios? In December 2014 the Environment Agency published Long Term Investment Scenarios (LTIS) for flood and coastal erosion risk management in England. It is a major achievement in long-term risk-based resource allocation, which incorporates a rigorous economic optimisation.

This paper sets out the headline results, and outlines the methods used to produce them, including the innovative economic model. It discusses both constraints in the current approach and opportunities for collaboration to improve the analysis, and engage with other infrastructure operators planning for adaptation.

Methodology: The analysis is based on the Environment Agency's national assessment of flood risk from rivers and the sea, along with the risk of properties flooding from surface water. The risk information informs an economic model to assess optimal levels of investment both in maintaining and improving the defence infrastructure, and is combined with a high level appraisal of investment in broader risk management activities (such as flood incident management).

Findings: The headline results describe optimal investment profiles in the short and long term, and compare these with planned investment levels by government and external contributors. The potential to reduce flood risk in the long term is described in the context of the efficiencies required to reduce and hold down costs, the benefits of maintaining control over development in the floodplain, and the effects of climate change.

Significance for practical solutions: There are constraints in the economic optimisation approach, as well as in the broader, inclusive overview of risk management activities, and the Environment Agency is seeking a more open, collaborative approach to develop LTIS and strengthen it further as robust, independent, world-leading evidence. A new government-industry-academia collaboration will form an LTIS Development Group to progressively incorporate the best science into LTIS. This group will provide opportunities for interested members of the academic community and other stakeholders to work together and innovate to address the common challenges of long term investment planning in the face of deteriorating assets and climate change.



ABSSUB-1401

SC 8.13 Trade-off analysis – a 21st century complement to cost-benefit analysis?

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Research question: Cost-benefit analysis was a valuable contribution of economists and engineers in the 20th century. It provided planners with a coherent and structured framework to rigorously evaluate human interventions (new policies or investments). It continues to play a foundational role in the decisions of governments and its impact continues to grow as its use expands in developing countries.

Over the last decades the method has been found not entirely fit for purpose in some situations including interconnected natural, engineered and economic systems, under non-stationary climate and other Knightian uncertainties, and when stakeholder groups play a significant role in public decision-making.

Methodology: Intervention assessments in such contexts, within single or multiple systems, can be undertaken using simulators that predict physically based outcomes and then quantify engineering, ecological, economic, and/or social impacts. Impact models typically output indicators which summarise engineering, environmental, or economic performance. Impact models can use a range of techniques: physical, ecological, economic, agent-based (behavioural), etc. As long as stakeholders judge impact models are sufficiently accurate and informative, they will be fit for purpose.

Findings: A trusted impact model can then be updated to simulate one or more new policies and/or investments to evaluate their impact under current conditions or future plausible states of the world (scenarios). Using system impact models various analyses and can be carried out to suggest and/or stress test various policies; these include for example Robust Decision-making, sensitivity analysis methods, dynamic adaptive pathways, many objective robust optimisation, etc. Most of these in some way output trade-off plots which summarise in two or more dimensions, how much is lost or gained as interventions are modified.

Significance for practical solutions: This talk surveys how several decision-making under uncertainty methods lead to trade-offs and discusses the uses and limitations of such results in shaping public policy and investment decisions. These include negotiating the allocation of benefits and the associated selection of interventions.

ABSSUB-222

SC 8.13 Understanding and managing climate change risks and adaptation opportunities in a business context

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Research question: Climate change poses complex challenges for business not only because of uncertainty associated with the timing and magnitude of projected changes but also because of the interconnectedness between risks and impacts in the modern globalized economy that result in numerous difficult to predict



consequences for economic activities. How can organisations deal with uncertainty and complexity associated with climate change?

Methodology: This paper looks at ways in which climate risk management can be embedded within a systems approach to scenario planning and organisational management aimed at enhancing the resilience and therefore profitability of companies in the face of climate change. The methodology is drawing on the practical experience with forward-thinking companies in the extractives, chemicals, power, transport, and agriculture sectors through the use of case studies and a methodological framework for dealing with climate risks. It introduces the concept of systems thinking for managing climate risk and developing adaptation strategies and presents four key steps that businesses can take to 1) understand climate context 2) assess climate risks and opportunities, 3) develop a business case for managing climate risk and build resilience throughout their value chain and 4) create a strategy to provide direction and ensure integration within the business. It also presents practical examples of how businesses are addressing these challenges through case studies in a number of business sectors.

Findings: There are traditional approaches for assessing and managing risks and can be supplemented and further analysed with systems thinking. Traditional risk management techniques can help manage and adapt to the operational risks amplified by changes in the frequency and severity of extreme weather events. Nonetheless, understanding of risks and their boundaries within a system, how they influence one another and manifest in impacts within a value generating system is of paramount importance to understand strategic implications arising from climate change.

Significance for practical solutions: The four step approach outlined in this paper aims to provide guidance on where to find information and how to interpret it within existing business processes. It draws on a systems approach to ensure that the full range of risks and opportunities are considered and that holistic approaches to managing and leveraging these are identified. It also presents practical examples of how businesses are addressing these challenges through case studies in a number of business sectors.

ABSSUB-1114

SC 8.15 Tracking adaptation: an overview of key challenges

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Research question: Tracking if and how adaptation has progressed over time and across countries is an important topic for scientists and policy makers. The methods through which the data is collected is very important for the credibility, legitimacy and salience of the findings. Several methods for adaptation tracking purposes have been used in the literature, including systematic web searches, systematic review of regularly submitted policy document (i.e. National Communications), expert perception surveys, self-assessments by governments, in-depth comparative case studies by scientists, or combinations thereof. Other methods have been proposed but hardly explored, including twitter scraping and media analysis. This paper aims to systematically assess and discuss the strengths and weakness of each of the abovementioned methods of collecting data for adaptation tracking purposes. In addition we aim to discuss how different studies have conceptualised their dependent variable for adaptation tracking and the specific indicators they selected for tracking adaptation over time and across countries.



Methodology: We use systematic review methods to identify and assess the methods employed by the peer reviewed and grey literature in the period 2000-2015.

Findings: Our results show a great diversity of the strengths and weaknesses between methods. Triangulation of several methods of data collection is advised, but which combinations are most suitable ultimately depends on the goal of adaptation tracking.

Significance for practical solutions: Insights from this study will allow for a more informed debate about the strengths and weaknesses of various methods. Understanding the methodological, conceptual and empirical challenges for adaptation tracking is of utmost importance to increase the consistency, comparability, comprehensiveness, and coherency of adaptation tracking.

ABSSUB-867

SC 8.15 National-level progress on adaptation among high-income countries

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Research question: The rate of adaptation implementation is increasing around the world, creating a need for new methods of measuring progress towards policy goals. This presentation elaborates on an area of research referred to as "adaptation tracking," which seeks to inform debate on the importance of measuring adaptation progress and on the concepts and metrics underlying tracking. Adaptation tracking can play an important role in helping governments and researchers understand overall progress on adaptation implementation and identify emerging adaptation deficits. We demonstrate one application of adaptation tracking by presenting evidence on policy change for 41 high-income countries between 2010 and 2014. The core questions asked in this study are:

- 1) Did the number of adaptation initiatives at the planning or implementation stage increase between 2010 and 2014?
- 2) If so, which sectors are seeing the greatest increases in adaptation implementation? What types of adaptation action are most frequently implemented?

Methodology: This study applies a novel, indicator-based global tracking methodology to the Sixth National Communications (NC6) of the United Nations Framework Convention on Climate Change. This framework was initially applied to the Fifth National Communications (NC5), providing baseline data from which to evaluate sectoral and country-level trends. We further utilize a quantitative proxy, the Adaptation Initiative Index (All), to compare adaptation progress at the country level.

Findings: Our results demonstrate an 87% increase in reported adaptation initiatives between 2010 and 2014, with the greatest observed increases being concrete adaptation initiatives like regulations or surveillance and monitoring. Leading adaptors in the NC5 continue to perform at the top of the NC6 Adaptation Initiative Index (Australia, Finland). Canada, New Zealand, Norway, Portugal, Sweden, and the UK also emerge at the top of the NC6 All. Notwithstanding this we also observe evidence of policy dismantling in several countries, raising important questions about the stability of new adaptation policies and initiatives within the context of shifting governments or political decision-making.



Significance for practical solutions: To our knowledge this is the first longitudinal study to be conducted about adaptation policy. The strengths and challenges of this methodology provide useful insights into opportunities for developing a robust framework for monitoring global adaptation progress and can inform future research on policy change across countries.



CROSS-CUTTING ISSUES

8. RISK ASSESSMENT, ADAPTATION PLANNING AND EVALUATION

CROSS-CUTTING ISSUES

9. INSTITUTIONS AND GOVERNANCE





ABSSUB-1248

SC 9.1 Normative architecture for groundwater governance: redesign to facilitate adaptation and inclusion

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Research question: Groundwater will both buffer and contribute to climate change impacts: serving as freshwater shortage (Green 2011, Kløve et al. 2014, Taylor et al. 2013) and contributing to sea level rise (Konikow 2011, Wada et al. 2012). Since a majority of climate change effects will be felt through the water cycle (IPCC 2013), ecosystems services of groundwater and drivers of groundwater use will shift accordingly. This has implications for achieving the five key conditions for inclusive development (Gupta et al., 2014) in the future. For example, increased pumping of non-recharging aquifers due to drought should be both regulated and monitored according to the needs of the reliant communities. Simultaneously, long-term adaptations to water availability challenges should be developed with their participation and consent. Therefore, this research responds to the question: *How can redesign of the normative architecture for groundwater governance facilitate adaptation in the context of inclusive development?*

Methodology: To respond to this question, the paper reviews the relevant literature and presents the result of a multi-level content analysis of global, regional, transboundary and national groundwater governance texts. It characterises the normative architecture of groundwater governance (IDGEC 2005, ESG 2009) according to patterns and gaps in the range of principles, rights, and measures in the texts. These patterns and gaps are then assessed for their fit with ecosystem services of groundwater (Knüppe and Pahl-Wostl 2011, Knüppe and Pahl-Wostl 2013, Bergkamp 2006) and the drivers of groundwater use. Groundwater governance in the Stampriet transboundary aquifer in Southern Africa is used to illustrate these linkages. Finally, redesign of the existing normative architecture is proposed.

Findings: The analysis shows that the existing design of the groundwater governance architecture has three key shortcomings. First, it is primarily based on norms developed for surface water resources and thus does not account for the full range of drivers that lead to groundwater abstraction and pollution. Second, the architecture is not sufficiently robust to cope with changing groundwater flows and the related ecosystems services most effected by climate change. Third, the architecture is especially weak in areas critical to an inclusive governance approach - namely public participation, access to information, and rights of women, youth and indigenous peoples.

Significance for practical solutions: Since most places have yet to experience significant groundwater problems, a practical solution is to begin consultation processes that identify key drivers of groundwater use; inventory ecosystems services that might be effected by climate change; create adaptive mechanisms that address them; and develop a normative architecture on this basis. This research is the first content analysis of groundwater governance texts using the ecosystems services and multi-level governance concepts to draw conclusions about adaptation.



ABSSUB-372

SC 9.1 Flood risk governance in Europe: how eight key issues are being dealt with in six European countries

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Research question: European countries, especially urban areas, face increasing flood risks due to urbanisation, increase of exposure and damage potential, and the effects of climate change. In literature and in practice, it is argued that a diversification of Flood Risk Management Strategies (FRMSs) makes countries 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, but it also requires these arrangements to be tailored to their physical and institutional context. Within the EU FP7 project STAR-FLOOD (2012-2016), a comparative analysis and evaluation of flood risk governance in The Netherlands, Belgium, Sweden, Poland, France and England has been conducted. The presentation will address the question of which key governance issues emerge from this comparative analysis and evaluation and how they are currently being dealt with.

Methodology: The presented findings are based on empirical research carried out by more than 40 researchers – including policy analysts and legal scholars – active at universities and research institutes in the six STAR-FLOOD consortium countries. Based on all project deliverables, a synthesis document is being written by the authors, drafts of which will be discussed with the involved researchers as well as STAR-FLOOD's Transdisciplinary Advisory Board. This will ensure that the relevance of the reported key issues is supported by the empirical findings.

Findings: The project identified at least eight key issues that are relevant for all researched countries (and probably also beyond), being how to: (i) link between water management and spatial planning; (ii) balance the need for local flexibility with that for guidance at a centralised level; (iii) combine integration and diversification of FRMSs; (iv) promote risk awareness and involvement of the public in FRM; (v) stimulate normative debates behind decision making; (vi) promote trans-boundary flood risk governance; (vii) optimise EU policies, including the Floods Directive; (viii) implement improved FRM through appropriate rule systems. Drawing on all project deliverables, the presentation will briefly review each key issue, discuss salient similarities and differences between the countries and point at ways forward.

Significance for practical solutions: Good practices for flood risk governance related to each of the eight key issues have been identified. Addressees of the good practices are public policymakers at the (inter)national, regional and local level, private parties, researchers, but also residents and NGOs.



ABSSUB-407

SC 9.1 Adapting to a variable climate through a private property regime: the case of the Azapa aquifer

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Research question: Water in Chile is managed through a private property regime installed by the Water Code of 1981, which introduced Water Use Rights (WUR) favoring the establishment of a water market. The Azapa aquifer is located in the Azapa valley in the north of Chile and supplies irrigation and drinking water in a region characterised by its desert climate. The region is exposed to natural cycles of rain deficit and floods, which can vary due to climate change impacts, making the community's capacity to adapt to these conditions essential to manage its water resources. This study aims at analyzing how this institutional arrangement has worked in the Azapa aquifer and define key issues that need to be improved in order to cope with changes.

Methodology: To collect data, a multi-method set was used consisting of a Bibliographic review, a secondary analysis of interview and workshop transcripts, and eight semi-structured interviews with key actors, which were conducted in 2013. For analysing the information the Institutional Analysis and Developmental Framework (IAD) was used, a multi-tier conceptual map under which major types of structural variables that are present in any institutional arrangement are identified.

Findings: This institutional arrangement is composed of two main elements: The Water Code's rules and the decisions of local appropriators. The Code establishes that a person is legally allowed to extract groundwater when in possession of a WUR for the volume it specifies; yet, there is a lack of information on the number of WUR holders and the allocated groundwater caudal, which brings uncertainty to the enforcement of rules. Most WUR are of the type consumptive, permanent and continuous. This, together with low technology requirements and the absence of an operative Water User Organization (WUO), results in most legal appropriators to be free to decide when and how to exercise their WUR. Thus, decisions on groundwater extraction mostly depend on appropriator's needs, which relate with generating profits. There is an undetermined number of illegal appropriators who extract groundwater through illegal wells. Those are commonly used to complement surface irrigation water increasing extraction in periods of water scarcity when surface runoff is not enough to satisfy the valley's demand. This way, appropriators' decisions relate to the aquifer's recharge cycle, which is determined by the occurrence of extraordinary rainfall events, every 5 to 8 years.

Significance for practical solutions: This particular arrangement lacks flexibility to adapt to climate variability and could fail to cope with future climate change impacts. In this context, it's relevant to analyse and identify weaknesses and strengths that need to be addressed in order to allow local institutions to successfully translate future initiatives and facilitate adaptation to climate change.



ABSSUB-561

SC 9.1 City blueprint: assessment of the sustainable integrated water resources management in 45 cities

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Research question: How can cities be assisted in applying Integrated Water Resources Management?

Methodology: The City Blueprint is an indicator assessment that evaluates the city's Integrated Water Resources Management (IWRM). It is a first step in the strategic long-term planning process towards sustainable IWRM in cities. This assessment distinguishes two frameworks, i.e., a Trends and Pressures Framework (TPF) and a performance-oriented City Blueprint Framework (CBF). The 12 TPF indicators (on which the city's IWRM has a negligible influence) may create awareness of the most stressing topics that either hamper or, on the contrary, pose opportunity windows for IWRM. The CBF consist of 25 performance-oriented indicators that measure the city's own efforts, performances and possibilities to improve. These indicators are divided over 7 categories, i.e., water quality, solid waste treatment, basic water services, wastewater treatment, infrastructure, climate robustness and governance. Next, the indicators are geometrically aggregated into one score, i.e., the Blue City Index (BCI). Our work is part of the European Innovation Partnership on Water of the European Commission (http://www.eip-water.eu/City_Blueprints) and is a Watershare tool (<http://www.watershare.eu/tool/city-blueprint/start/>).

Findings: Infrastructure leakage rates appear to be particularly high, on average 21% and 11 cities exceed 40%. Less than 50% of the wastewater is treated by nutrient or energy recovering techniques. Many cities (including Copenhagen and most Dutch cities) do insufficiently separate wastewater from stormwater (only for 50% of the cases). Typically, only a few cities apply adequate climate adaptation. Developing cities experience many pressures which may seriously limit their ability to improve their IWRM, whereas the priorities to do so are high. Based on the results of 45 municipalities and regions, 5 different levels of sustainable IWRM are identified, i.e., (1) Cities lacking basic water services, (2) Wasteful cities, (3) Water efficient cities, (4) Resource efficient and adaptive cities, and (5) Water wise cities.

Significance for practical solutions: The assessments has been applied on 45 municipalities and regions in 27 countries, mainly in Europe and the results are important as there is currently no quick-scan or framework to benchmark urban IWRM. As rapid urbanisation and climate change may lead to flooding, water scarcity, pollution, adverse health effects, and rehabilitation costs that may overwhelm the resilience of cities. Furthermore, IWRM is often hindered by a lack of awareness, integration and cooperation amongst various stakeholders, decision makers, companies, and citizens in general. The City Blueprint is a first step in the strategic long-term planning that considers the full watercycle. The indicator assessment is able to compare cities and cluster cities with similar problems. Hence, city-to-city learning as well as the exchange of experiences, knowledge and best practices are enhanced.



ABSSUB-431

SC 9.1 Concepts and tools for selection of urban water policies for climate adaptation: a comparison

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Research question: With the inherent uncertainties in climate change and its impacts, a considerable number of research studies is now available on policy-making under uncertainty, developing resilient cities, adaptive policies and systems, and related concepts and tools. Policy documents slowly start to mention such concepts and tools, but it is yet unclear how they are actually being used in practice.

Methodology: The discussion on concepts (and terminology) related to climate change adaptation is still far from concluded and many tools are still being developed. Hence, we first briefly establish a common understanding of concepts and tools for use in the analysis. Next we compare the conceptualisations of uncertainty in relation to climate change adaptation policies that have been used in three cities to inform the selection of urban water resource management and flooding policies. The three cities are London, Rotterdam and Singapore, all of which are known to have active climate adaptation planning. The analysis is carried out through a review of policy documents, interviews with experts and secondary sources such as newspaper articles. We compare the approaches in the three cities at the broad conceptual level and/or at the micro level, and include aspects such as implementation of flexible policies and infrastructure solutions, time horizon adopted, discount rate used, modelling of distributional effects, etc.

Findings: The three case studies demonstrate that considerations of uncertainty have already been integrated into the policy-making process for flood management and water resource planning in these cities and their surrounding regions in some respects. Policy documents refer to uncertainty and approaches to policy and investment appraisal have in some cases been modified to take uncertainty into account. However, the case studies also reveal considerable tensions in adapting the policy process to take full account of uncertainty: firstly, methods for policy-making under uncertainty are sometimes difficult to build into standard approaches to policy appraisal; secondly, rigidities are imposed by the existing legal and regulatory framework; thirdly, the higher costs of building flexibility into long-life infrastructure are in tension with strict budget constraints that exist at local and national levels; and, finally, policy-makers face strong pressures to demonstrate that they are taking "appropriate" action in the short-term, particularly in the aftermath of a storm or drought event with high political salience, even if this is not entirely consistent with long-term planning and policy decisions.

Significance for practical solutions: The study gives learning points from the three cities, which can be relevant for other cities to (re-)design the policy process to support the selection of policies for climate adaptation.



ABSSUB-1383

SC 9.2 A practitioner-based framework of power relations for enabling successful adaptation projects

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Research question: In recent years, international and national bodies have increasingly focussed on adaptation to climate change in response to increasing risks of extreme events perpetuated by climate change. However the lack of evidence of what constitutes 'successful' adaptation, threatens to lead adaptation decision-making along familiar paths that favour technological, or engineering solutions. Without the wider participation of relevant stakeholders, adaptation projects are at risk of unintentionally enabling elites to capture resources and compound the vulnerability of those most at risk to climate change (Nelson & Stathers 2009).

Processes of adaptation articulated in the literature often include, implicitly or explicitly, conceptions of power: for example the role of the state, key individuals driving transformation, and the agency implicit in community-based adaptation. However, to date climate adaptation research has failed to deliver fully explored integrative theories of social change able to explain the diverse dimensions and outcomes of power - here defined as 'asymmetrical social agency' - in adaptation (Taylor, 2013). In practice, actors may have difficulty articulating and communicating issues of power, despite their key role in affecting adaptation outcomes.

In response, researchers are examining approaches that place more emphasis on enabling stakeholders to enhance their ability to adapt through so-called 'emancipatory transformations' (Scoones et al., 2015). This body of work asks how people can be enabled to intervene and influence processes of adaptation decision-making (Inderberg et al., 2015). A key tool in this process are practical frameworks for understanding how people are made vulnerable through actions of others and how these situations may be transformed. As such the aim of our presentation is solution-focussed and critically relevant within current adaptation decision-making across different scales.

Methodology: In order to understand how influences of power within decision-making are constructed and can be undone, an online survey was undertaken with adaptation practitioners focussing on perceptions of inclusive participation and positions of influence from different stakeholders in adaptation projects. This survey is compared with a systematic review of the scientific literature on the role of power in adaptation in order to understand the gaps in current framings and potentially useful contributions from both practitioners and scientists. From this analysis we develop a framework that takes account of the identified spectrum of power mechanisms.

Findings: The framework takes the look of key power issues that practitioners can consider when planning and evaluating adaptation projects.

Significance for practical solutions: Our evaluation enables practitioners to understand when the framework presented may be of use in highlighting issues of power within adaptation processes and thus identifying potential leverage points for transformative adaptation.



ABSSUB-1061

SC 9.2 Who, how and why 'must' participate in building resilience to disasters in a changing climate

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Research question: The resilience perspective has emerged as a plausible approach to confront the increasingly devastating impacts of disasters; and the challenges and uncertainty that climate change is posing through an expected rise in frequency and magnitude of hazards. Resilience is not passive and stakeholder participation has been largely posited as pivotal for building resilience- Who is involved and how they are involved are crucial aspects in defining the practices and processes for resilience. Nevertheless, there are few empirical studies available to inform theory or show how these issues are addressed in response to climate change. Therefore, this study focuses on revealing how practitioners frame the issue of participation within the resilience paradigm, how they construct practices and, in consequence its relevance in the realm of a changing climate and how, in consequence, practices and processes emerge.

Methodology: Using Hajer's (1995) 'Social-interactive discourse theory', in this interdisciplinary research, we study the frames and practices developed around a disaster management initiative in Australia: the Natural Disaster Resilience Program in Queensland. Within this approach, discourse is defined as 'a specific ensemble of ideas, concepts, and categorisations which are produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities' (Hajer, 2000:44). Therefore, discourse analyses are useful for the examination of multiple and conflicting concepts, ideas and narratives that society holds about an issue (Hajer, 2000). This resonates with this research, as resilience, Disaster Risk Management and climate change are controversial issues. The methods used were observation, document revision and in-depth interview for the study of the implementation phase of the Natural Disaster Resilience Program (NDRP), at the state level and local levels (Charleville and Gold Coast) in Queensland, Australia.

Findings: What emerges from the research findings as critical and requiring urgent attention is stakeholder and especially local government and community participation, and for this to become socially relevant, challenges such as meaningful communication and power structures need to be addressed. What is also critical is to move from experiential learning to social learning.

Significance for practical solutions: Additionally, the results presented here offer empirical evidence on how broadening the pool of actors can be implemented, and the opportunities that this opens up for building resilience.



ABSSUB-1245

SC 9.2 Asking the right questions: developing a gender integration guide for local adaptation practice

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Research question: The effects of climate change, such as increased frequency or intensity of extreme events, impact complex social structures in societies. These structures mediate responses to climate changes through their effects on determinants of vulnerability, for instance gender, ethnicity, socio-economic status, living conditions, or health status. To create measures suitable for all target groups in a given society, an awareness of gender as an important cross-sectional identity category is needed in strategies. Until now, gender impact analyses are not standard approaches in adaptation design, implementation or evaluation. This project asks how such integration can be achieved at the local level.

Methodology: A workshop-based format was designed to elicit information from stakeholders on how to integrate gender aspects into their climate change mitigation and adaptation practice. Gender experts were invited to share their knowledge during these workshops. Literature searches on suitable questions from existing gender impact analyses templates that can be applied to local adaptation situations complemented the interactive research format.

Findings: During the workshops, discussions with stakeholders revealed a general sensitivity towards societal diversity, yet distinguishing between specific needs of different groups of women and men was perceived as challenging. When asked to test their strategies for outcomes on different groups of men and women and on gender relations, participants expressed an interest in step-by-step guidelines, which currently do not exist for the adaptation sector. Findings suggest that it will be necessary to provide tailored templates for asking questions about power relationships, effects of adaptation on biological, institutional, social, or cultural determinants of gender equity, and deliberating on how appropriate different measures are for different target groups if we hope to encourage a stronger inclusion of equity concerns into local adaptation practice. Such templates could be based on checklists, decision trees, or interactive assessment forms. An example of such a template is described.

Significance for practical solutions: The social components of adaptation have long been recognized in the scientific community, yet the translation of this knowledge into gender mainstreaming mechanisms in local adaptation practices is incomplete. To increase social justice and use the transformational potential of adaptation, guides that outline how gender relations may be impacted by climate change and adaptation, and which questions to ask in a first gender impact assessment during the planning stages, could be useful. This project suggests developing these guides with input from stakeholders. These guides may subsequently be disseminated amongst local decision-makers.



ABSSUB-464

SC 9.2 Orchestrating adaptation, mitigation and transformation

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Research question: Cities represent a key anchor point for acting on climate change and integrating mitigation and adaptation into broader agendas of sustainability and welfare. However, urban governance structures often remain fragmented which obstructs coordination and consensus between addressing climate change and other social, economic and environmental problems. The objective of this research is to reveal what type of interactions between different actors produce the governance capacities for building resilience against possibly extreme climate impacts and promoting sustainability to overcome persistent drivers of climate change and other socially undesired impacts.

Methodology: Based on resilience, transitions and climate literatures we develop an agency's governance capacities framework to reveal how collective actors' abilities combine to produce governance outputs and outcomes towards building resilience and promoting sustainability. We identify different types of governance interventions that enable adapting, mitigating and transforming and orchestrating between them to produce synergies and reduce trade-offs. We apply the framework in an in-depth comparative case study of the governance capacities in New York City and Rotterdam to explore how and to what extent governance capacities are established in practice. The case study builds on different data sources, including workshops, interviews with policy-makers, practitioners and scientists and grey literature.

Findings: Rotterdam and New York City both are important urban delta cities that are vulnerable to climate change impacts and that face numerous regeneration challenges and complex social patterns. They are frontrunners in climate adaptation, having put ambitious strategies and programmes in place. While Rotterdam is preparing to protect, New York City focuses on rebuilding and recovery. The case study reveals how different adaptation and mitigation strategies on the system output level lead to co-benefits and/or trade-offs across sectors and how more transformative cross-sectoral strategies can be developed and promoted. It shows how actions can be aligned and mediated across scales and sectors through meta-governance networks that ensure exchange and flow of knowledge and experiences to streamline climate mitigation and adaptation into broader sustainability and urban planning agendas.

Significance for practical solutions: The insights from this research provide a better understanding of what interventions contribute to governance that builds resilience to climate impacts and promotes sustainability. The framework helps to differentiate between different types of interventions that simultaneously enable to safeguard critical sustainability values, anticipate possibly detrimental future effects and transform underlying root causes of unsustainability drivers and vulnerabilities. This enables to understand how the different interventions, strategies and actions can be aligned and mediated to produce synergies and reduce trade-offs across sectors and scales.



ABSSUB-876

SC 9.2 Role of power in climate change adaptation: explaining the shaping and adoption of CCA approaches in South Asia

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Research question: Climate change is adding new risks and increasing fluctuations, further aggravating the existing vulnerabilities. Consequently, the decision makers face deep uncertainties due to other external factors such as population growth, new technologies, and economic developments. Traditionally, decision makers assumed that future can be predicted, and an optimal plan can be developed to meet the desired objectives. But, with complex system regimes and climate change the future looks uncertain and the plan is likely to fail. Climate change adaptation becomes part of this uncertain decision-making and policy storyline. However, there are several approaches to decision-making – focusing on socio-political processes. In this research study, I emphasize on how exercise of “power” influences the future decision-making for climate change adaptation and why these adaptation processes are beneficial to some and detrimental to others. Research would further endeavour to map power dynamics between actors – especially focusing on the aspects of agriculture adaptations. This further elucidates that how “power” catalyses or hinders the critical moment and adaptation pathways thinking in the south Asia. Adaptation pathway provide insight on sequencing of actions over time, potential blockades, and path dependencies.

Methodology: In order to capture the process dimensions of this research idea, specifically the power dynamics between actors, the research uses a qualitative method. Closed-door semi-structured interviews with the key informants are conducted to understand aspects of relational power across south Asia (India, Nepal, and Bangladesh). These interviews reflect the political processes using the concept of relational power – particularly through the “bargaining” and “social” power dimensions with reference to the structural positions of actors in the wider network of actors. It further reviews different government department web pages, government orders, meeting reports, and policy documents to map the key government and non-government actors responsible and involved for decision-making.

Findings: The research maps the key actors in the governance network of climate change adaptation in south Asia (India, Nepal, and Bangladesh) involved in decision making for climate change adaptation. It further reflects and details out the historical and current political processes and power dynamics with reference to “power” in the three south Asian countries, also highlighting the usefulness of the critical moments and the adaptation pathway approach in decision-making.

Significance for practical solutions: South Asia is vulnerable to the impacts of climate change; hence, appropriate decision-making will be useful in the future. The South Asian countries are still planning to implement various agriculture adaptation plans in the near future, thus this research can demonstrate the positive usage of “power” in the adaptation decision-making and how the concept of critical moment and adaptation pathway can be a key element to it.



ABSSUB-983

SC 9.3 Bringing together climate, science and policy in Latin America: a study of three cases

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Research question: There is an increasing need for a robust climate governance able to implement adaptive strategies that could reduce the risks and the increase the opportunities related to the impacts of climate change. To strengthen climate governance it is fundamental to establish a smooth interface between scientists and policy-makers capable to generate solid knowledge based climate policies and programmes able to support successful adaptive strategies. The interface, however, has been highly problematic in many countries due to the uncertainty and complexity of climate change, as well its contentiousness, which impose barriers to the communication between scientists and policy makers. This paper discusses the implementation and results of a study of scientists and policy makers in Argentina, Bolivia, and Chile aimed to address the following research question: what are the main strengths and weakness of the interface between climate scientists and policy makers in the perspective of improving climate governance?

Methodology: To provide an answer to this question the methodology focused on two dimensions (a) the differences and similarities that exist between the climate knowledge produced by climate scientists and the knowledge needs of policy makers; and (b) the roles played by the dimensions of scientific evidence, connections between scientists and policymakers, and context in affecting the supply and demand for climate knowledge in the interface. Researchers in each country selected several climate adaptation science projects (most of which included specific policy components), researching the background of the projects and then interviewing scientists and policymakers associated with the projects in relation to the two dimensions stated above.

Findings: The findings of this study shed light on important dynamics of the science and policy interface and of the challenges of policy oriented projects in each one of the countries. The study identified several issues that characterise the science and policy interface between in each of the countries, such as the existence of different knowledge cultures between scientists and policy makers, the institutional conditions that characterise the interface, the absence of proper and stable communication channels between the two communities, and the need for actors able to mediate between scientists and policy makers.

Significance for practical solutions: The project provides significant insights that are relevant to science, policy, and society to the extent that they could contribute to (a) a better understanding among researchers and policy makers of policy oriented projects in the area of climate, (b) an improvement in the design of future policy-oriented research projects and some of those already in progress, and (c) the development of useful and practical recommendations oriented to improve the interface and, consequently, the capacity of governance to develop better climate policies and strategies.



ABSSUB-692

SC 9.3 Towards more informed climate adaptation: ethics in stakeholder participation and decision-making

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Research question: There is increasing focus on how to best support decision-makers adapting to climate change. To date, much of this focus has been directed at assessing how decision-makers themselves navigate and manage risk and uncertainty in deciding to what extent they should adapt their own businesses and practices. We argue, however, that scientific researchers also have a key role to play in supporting these adaptation decisions. Specifically, it is increasingly acknowledged that the communication of timely, useable and relevant findings to those who will apply them is critical. However, it is equally important to identify and guard against the implicit risks that can be created in the communication of research findings. For example in the context of climate change, through researchers failing to outline the full list of adaptation options available to decision-makers, publicising their research findings as accepted and uncontroversial inputs into decision-making processes, or by not declaring other conflicts of interest. Such practices may be implicit or even exacerbated by our institutional structures but they have the potential to increase the risk exposure of decision-makers, with downstream impacts to broader societal well-being. The risks outlined above, however, are seldom, if ever, examined in the context of adaptation decision-making. Our research questions include: Can we identify key ethical shortcomings of current practice in adaptation research? How are these dealt with in other domains of professional practice? Can we identify changes in practice and institutions that can improve the interaction of research with industry, community and policy decision-makers?

Methodology: We assess from the literature existing instances where adaptation practice may fall short of professional practice in other domains (e.g. the medical sector), then integrate approaches from other practice domains several key innovations that could provide appropriate checks and balances so as to support full disclosure in the communication of adaptation research findings to decision-makers (i.e. where both strengths and limitations of research and the costs and benefits of different adaptations are transparent). We then draw from the institutional design literature to suggest ways forward.

Findings: We find that in recognising the ethical challenges that exist at the interface of adaptation research and decision-making, there are clear opportunities for researchers to more proactively manage the support of decision-makers.

Significance for practical solutions: We identify important opportunities to 1) improve participatory research approaches and change institutional arrangements that could reduce risk among decision-makers trying to adapt, 2) that improve the co-design of adaptation solutions, and 3) that reduce the risk of backlash from decision-makers due to perceptions of poor professional practice from the science community dealing with climate adaptation.



ABSSUB-970

SC 9.3 A systemic approach to developing responses to climate change

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Research question: The range of consequences brought about by climate change is so large that it is difficult to fathom. There is also a lot of uncertainty regarding the specific local impacts of climate change, and its dynamics make it necessary to find ways to develop responses for the long-term. These combined challenges create a complexity that call for novel approaches to enable all actors to develop a long-term systemic and shared understanding of the consequences of climate change.

Methodology: To that end, the European Commission's Joint Research Centre (JRC) embarked on an innovative effort combining scenario building and a serious gaming platform. This combined approach makes it possible for any participant to explore plausible alternative sustainable transition pathways from their own perspective and to test any realistic strategy of their choice to reach their desired long-term objectives in a world that changes as players journey into the future.

The first step of the initiative was to construct four alternative scenarios for possible transitions towards a sustainable future using a classic foresight scenario building approach. The resulting scenarios have proved to be sufficiently broad and robust to be used as a discussion framework to explore the future of specific issues in more detail. However, doing so in standard meeting formats fails to generate a strong engagement and ownership from the participants. Gaming appeared to be a more powerful approach to enable participants to immerse themselves in the scenarios and to engage with other stakeholders, while developing content and understanding that is relevant to their own situation. As a result, the study team developed a serious game (the JRC Scenario Exploration System (SES) that provides a simulation platform for the players to act as a business, a policy maker or a civil society organisation in the context of the scenarios. Public opinion is also represented. Players are led to operate in at least two alternative scenarios over a 20 year time horizon.

Findings: The SES has been tested successfully on a very wide range of people (across ages, gender, professions, thematic domains, etc.), both in a generic scenario exploration mode for awareness raising and in a thematic mode for strategy and policy development. Following its real life application in the food safety area, the thematic mode has proven to be a powerful way to make policy makers and other stakeholders think beyond their usual mental models and discover unexpected consequences of their actions linked to the realistic combination of external factors and to the actions of the other players.

Significance for practical solutions: We are now confident that this combined approach is a powerful tool to help many people from all stakeholder groups come together and work on strategic preparedness and resilience to overcome climate change. The next application of this future oriented serious game is planned to be for the forthcoming review of the EU Water Framework Directive by the European Commission.



ABSSUB-1255

SC 9.3 Assessing the effectiveness of multi-sector partnerships in the Jucar River Basin to manage droughts

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Research question: South-eastern Spain is a drought prone area, characterised by climate variability and water scarcity. Approximately every ten years the area suffers from an important drought and in between, lower drought events might also happen. The Jucar river basin, located in Eastern Spain, has a long tradition in adaptation to droughts. Since nearly a hundred years institutional and non-institutional strategies to face droughts have been quite successful through the development of collective management institutions and partnerships around drought management. Multi-sector partnerships are voluntary but enforceable commitments to reduce risks and gain mutual benefit between public authorities, private enterprises and civil society organisations across sectors. In this paper we show how the creation and institutionalisation of two entities has supported an efficient drought risk management: (1) The river basin authority (*Confederación Hidrográfica del Júcar*), aiming at improving drought resilience in the basin in the medium-long term; (2) and the permanent drought commission (*Comisión permanente de la sequía*), oriented to the governance and the decision making processes of droughts in the short-term.

Our research aim is the analysis of the factors contributing to the success of this kind of partnerships in the management of drought risks. The reason behind is the successful management of drought and the possibility of knowledge transfer on the creation of such institution to other geographical areas with similar risk conditions.

Methodology: To analyse the effectiveness of the governance processes of Multi-Sector Partnerships, we have adapted the Capital Approach. The five capitals proposed by Goodwin in 2003 and adapted to hazardous environmental events by Carmona et al. 2015 (forthcoming), help us identify and analyse the effectiveness of the functioning of both Multi-Sector Partnerships.

Findings: Using an indicator framework based on factors that facilitate the analysis of capitals, we highlight the governance strength and weakness and the economic implications of both Multi-Sector Partnership with the aim of enhancing drought management.

Significance for practical solutions: This kind of analysis allows not only a steady-state study of the partnership but also a dynamic analysis over time of the changes that the partnership has undergone to be successful in dealing with droughts.



ABSSUB-711

SC 9.4 Adapting to climate change across boundaries – lessons from a territorial approach in Senegal

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Research question: Urban and rural areas are increasingly integrated through political, economic, social and ecological processes which transcend administrative boundaries, leading to common problems and opportunities between bordering jurisdictions. Climate impacts do not adhere to conventional administrative and governance boundaries. Joined-up action across municipal and other spaces is thus key for adaptation measures and processes that straddle administrative boundaries. Yet, there has been limited research attention to these issues. In this paper, we aim to address this gap by focusing on a case study of the development and implementation of two cross-boundary approaches to climate change policy in Senegal: 1) the Territorial Approach to Climate Change in the Ferlo and 2) the Plan Climat Territorial Intégré for Dakar. The aim of this research is to investigate and better understand the opportunities and challenges to integrative governance for climate change adaptation. Through the lens of these two approaches we examine the role of institutional and socio-political drivers in influencing the design and delivery of climate policy and adaptive capacities across borders. In particular, we investigate: i) the governance structures and processes for cross-boundary planning and implementation and the extent to which they are relevant for adaptation; ii) the institutional and regulatory factors that support or constrain cross-boundary collaboration for adaptation; and iii) how motivations and incentives for cross-border collaboration can be enhanced and barriers overcome.

Methodology: Our methodology takes a three-step approach: 1) We develop a conceptual framework based on a critical review of the international literature on multi-scalar governance arrangements for environmental and land use planning; 2) We analyse relevant environmental, land use planning and climate change policies in Senegal; and 3) We undertake semi-structured interviews with key stakeholders involved in the TACC and PCTI approaches in Senegal.

Findings: Initial findings reveal that decentralised and effective multi-scalar governance, especially horizontally between bordering local authorities, offers multiple benefits by more effectively tailoring decisions to local environmental, economic and socio-political realities, but is constrained by key elements: inadequate capacity to address the full range of potential climate shocks and stresses on multiple variables and potential solutions; underdeveloped systems and policies for managing environmental and other resources that span administrative boundaries, leading to missed opportunities and adverse impacts.

Significance for practical solutions: From a policy and practical perspective the research is important for advancing existing adaptation policy and measures through rethinking the way in which adaptation is conceptualised and planned for beyond conventional planning borders, urban-rural dichotomies and other divisive approaches at multiple scales and to develop collaborative approaches.



ABSSUB-1060

SC 9.4 Climate change: business as usual or a complex issue? Let's ask practitioners

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Research question: There is a growing recognition that conventional business as usual approaches and routine framing of climate change are insufficient to address the challenges of a changing climate. Consequently, framing climate change as a complex issue has emerged strongly in the literature. Nevertheless, few studies have focussed on exploring practitioners understanding about the complexity of climate change. This is relevant as the frames that people hold, shape practice and policy options. This paper discusses the results of a discourse analysis of climate change conducted with stakeholders involved in Disaster Risk Management (DRM) initiatives.

Methodology: The case study for this research was the Natural Disaster Resilience Program (NDRP) during its implementation phase at the State level in Brisbane, and at two sites at a local level, Charleville and Gold Coast, in Queensland, Australia. The methods used in this research were in-depth interviews, observation and document analysis and the framework of analysis was the typology of emergencies developed by Handmer and Dovers (2007).

Findings: Based on the typology of emergencies developed by Handmer and Dovers (2007) that define them as routine, non-routine and complex, we found that stakeholders frame climate change in divergent ways. Results show that there is a tendency to frame the problem as challenging and complex, based on the threats. Importantly, even though the threats are framed as complex, policy and practices solutions are often framed more as routine rather than complex.

Significance for practical solutions: Therefore, if solutions are framed as part of routine processes, the promotion of more complex solutions needs to be carefully analysed case by case as in some cases complex solutions may be best, but in other cases more routine approaches may be preferable. In this case especially it may be unnecessary to change some existing DRM practices and policies; rather, revising and adjusting specific practices and policies may be a more convenient, effective and less painful strategy. The practical implications of this are discussed.



ABSSUB-1375

SC 9.4 Governance, institutions and practice for adaptation: adequacy and enhancements from New Zealand

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Research question: Adaptation to climate change requires governance and institutional frameworks that can be flexible to address the uncertain and dynamic effects of climate change on human systems and robust enough to enable capacity within organisations and communities that can navigate the political and contested preferences of private and public interests. The uptake of current adaptive management institutions for addressing climate change impacts has been slow to develop and is contested in many parts of the world. This paper presents insights from a New Zealand-based empirical study on the adequacy of institutional frameworks and practice for adapting to climate change in a highly devolved but multi-level governance system.

Methodology: A three-part typology and decision-relevant criteria are presented for assessing the adequacy of current formal governance and institutional frameworks and the practices derived from them. This is based on an examination of four conceptual bases for addressing uncertainty and dynamic climate change—the precautionary principle; risk management, adaptive management and transformational change—and qualitative assessment of practitioners experience.

Findings: The space for institutional enhancements through entry points are suggested, following identification of barriers, enablers, and lessons from non-climate analogues, to address the implementation gap between frameworks and practice.

Significance for practical solutions: This contributes to discussions on the potential for new governance and institutions for effective climate change adaptation.



ABSSUB-1447

SC 9.4 Urban local governance towards mainstreaming disaster risk reduction and climate change adaptation

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Research question:

1. What is the state's strategy and initiatives for urban local governance for Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA)?
2. What Comprehensive Disaster Management Programme (CDMP II) is doing and how?
3. How a local initiative is contributing to state's policy and plan with DRR and CCA in urban context?
4. How both the initiatives could be intertwined?

Methodology:

1. Secondary data collection on urban local governance in Dhaka, Bangladesh
2. Information gathering on CDMP II
3. Interview policymakers, implementation authority and the beneficiaries
4. Follow an initiative of the tiny farming community Krisoker Sor (Farmers' Voice)

Findings: Bangladesh has a unitary form of government with a declared policy of decentralized administration and strengthening of local governments. The local government system is composed of urban local governments, with city corporations for large cities and Paurashavas for secondary cities and small towns. Many small towns are still outside the municipal governance system and administered under the rural local government, such as Union Parishads. As of now there are 7 City Corporations and 314 Municipalities/ Paurashavas, although the number of urban centres is over 522. The urbanisation was very low throughout the British period (1757-1947), some individual cities and towns did grow significantly. Since the adoption of Bengal Municipal Act 1864, there have been many changes in urban municipal governance.

The key findings from the study is that the integration of local interventions into the national development planning with decentralization of authority is vital to ensure local ownership and the implementation of Sendai Framework for Disaster Risk Reduction. Local authorities should have the responsibility of implementing disaster risk reduction plan, and be accountable to the community they represent in doing so. Although it is important that support be readily given to assist authorities in this task, it is imperative that the local government assumes 'responsibility' and 'learns through doing'.

Significance for practical solutions: This study has significant importance of risk informed sustainable development through mitigating disaster risk in urban context, thus to make city resilient against disaster and climate risks. It also shows the way of transforming 'professional responsibilities' into 'emotional liabilities'.



ABSSUB-1496

SC 9.4 What is an appropriate policy response for adaptation?

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Research question: Recent scientific literature has raised the question of non-proportionate policy responses in different areas, where policies can underreact, i.e. fail to respond sufficiently strong on an impending challenge, or overreact by spending too much time and resources on a problem that can be objectively shown to be small. Policies focusing on adaptation to climate change are not immune to the risk of non-proportionate policy responses. In fact one can argue that because of the long-time perspectives involved it is particularly prone to non-proportionate responses. Our research question is how one can operationalize the proportionality in adaptation policy and which factors need to be taken into account in determining a proportionate policy response.

Methodology: We have investigated the appropriateness of the adaptation policy responses by analysing adaptation in Finland using an analysis that contrasts the development at the national level in the form of national adaptation strategies and plans with the level of cases at the local level. The data has been collected in the EU-project BASE. The analysis is based on interviews with stakeholders at these different levels coupled with detailed information on actual cases where adaptation action is undertaken or considered. The match or mismatch between the policies put in place and the reality in the cases exist is examined. We use detailed information both of the potential climate change and the governance responses at the local level.

Findings: We find that non-proportionality is a real risk in cases which require large infrastructure-like constructions. In these case non-proportional policy responses may lead to serious over- or underinvestment, whereas actions that focus on learning can naturally iterate towards proportionality. The determining factor is not just the investment itself but also the interests that it generates and its institutional framing that lead to a strong path dependency

Significance for practical solutions: The significance of the study and its emphasis on proportionality is that it shows what needs to be addressed in progressing from broad general strategies that state general principles to concrete plans that commit time and resources to adaptation. For large investments timing is a critical and in developing adaptation pathways one needs to carefully consider how to achieve proportionality by mixing different types of measures in an adaptively. This means in practice the creation of a dialogue that is informed by regular evaluations of different types of policy responses and also experiments of small or intermediate scale investments in adaptation. This will require policies that are designed to allow for different type of responses rather than a single normative response.



ABSSUB-1088

SC 9.5 Climate change adaptation: implementation barriers and enablers across Europe

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Research question: Recent research on the barriers and drivers of climate change adaptation complains that, even though, comprehensive inventories of hindering and enabling factors are produced, discussed and empirically tested by scientists, few insights on the temporal dynamics of adaptation barriers, their causes and the interdependencies between different driving and hindering forces have been presented so far. It is suggested that actor-centred and comparative research would promote a better understanding of how to overcome adaptation impediments (Eisenack et al. 2014).

This paper relates to this request by comparatively analysing the determining factors for successful climate change adaptation under varying geographic, socio-economic, political and legal framework conditions. It aims to explore the barriers and enablers to adaptation in 23 local and regional case studies across Europe by using a common methodological framework building on the work of Lehmann et al. (2015). The main goal of the analysis is to better understand the underlying dynamics that influence adaptation success across Europe.

Methodology: Research was carried out in the context of the EU FP7 research project BASE, which aims to support action for sustainable climate change adaptation in Europe. The cases explore the implementation of adaptation in the sectors of coastal protection, flood risk management, urban infrastructure, agriculture, water basin management, nature conservation and health. For each case study a survey was conducted of all project partners implementing a case study. Empirical data was submitted from different sources including interviews, workshops, literature and policy documents review, experts' opinion, among others. At first, data was classified according to key driving and hindering factors, e.g. such as knowledge, actors, resources, measure type and regulatory framework, and underwent rigorous analysis relating single factors to the properties of the case studies and to each other.

Findings: Preliminary analysis shows that the relevance of the various driving and hindering factors discussed in the literature varies substantially across different development stages of climate change adaptation. Likewise, the strength and nature of the links between different key factors has an important impact on creating virtuous or vicious circles of adaptation action. Strategies combining different factors to prevent various types of deadlock and crises of confidence have been identified.

Significance for practical solutions: Our findings do not only provide important insights for the design of adaptation strategies and their implementation at different spatio-political levels, but also provides ground for further research related to the causes of barriers of adaptation, their dynamics and strategies to overcome them.



ABSSUB-1427

SC 9.5 Benchmarking government adaptation progress - identifying barriers and enablers

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Research question: The paper reports on a project aimed at: establishing the baseline activity and quality of NSW Government (a state in Australia) adaptation processes; identifying organisational capacity constraints that inhibit adaptation; and identifying the enablers that foster good practice.

Methodology: The NSW Government comprises a myriad of agencies with an asset portfolio of A\$265 billion (US\$185 billion). We have undertaken a comprehensive survey of government agencies (numbering more than 120) to establish baseline climate change adaptation activity. The survey was designed to classify where agencies sat on a spectrum from no action to full implementation and monitoring of adaptation activity – and various steps in between. The survey comprised a desktop instrument, follow-up interviews and a workshop to identify barriers and enablers. The survey was completed by agencies representing all sectors and account for approximately 75% of the assets of the government.

Findings: The project has developed an improved knowledge and awareness of leading practice climate change adaptation processes and established a stocktake of the processes being employed by NSW Government agencies to adapt to climate change - including management of climate change related risks to assets and services. A much improved understanding of NSW Government agencies' organisational capacity to adapt to climate change and has strengthened formal and informal networks, which support adaptation across NSW Government. The findings are feeding into whole of government processes to develop programmes and guidance to assist agencies and into policy processes.

Significance for practical solutions: This project is embedded in practice. It is delivered by government climate change practitioners with technical support from university researchers. By establishing an effective baseline, a strong evidence base has been developed to develop tailored programmes for organisations at the same stage of adaptation development. It also ensures that policy development is responding to actual needs not theoretical ones.



ABSSUB-1100

SC 9.5 Implementing climate change adaptation policies: problems of fit and response strategies

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Research question: The paper uses the emerging politics of climate change adaptation in Switzerland as an example to study bottom-up and top-down tensions within a multi-level governance framework. Climate change adaptation is used as a case study to investigate how problems of fit are dealt with and to analyse in what respect rescaling can be regarded as a response to problems of fit and as a strategy to reconcile bottom-up and top-down tensions.

Generally, problems of fit constitute a common feature of environmental governance and refer to the mismatch between the geographical extent of an environmental issue and the territorial scope of institutions affecting its governance. In order to tackle this mismatch the idea is to create institutional arrangements which are tailored to fit to the geography of the environmental issue.

Methodology: Using Switzerland as a case study and drawing from document analysis and stakeholder interviews the paper first illustrates the functional, temporal, and spatial mismatches between climate change impacts and the territorial scope of institutions affecting the governance of climate change in Switzerland. Second, the paper looks at the institutional arrangements as well as rescaling strategies and projects created to tackle this mismatch. The paper wants to apply scalar thinking and the concept of rescaling to the issue of climate adaptation. Drawing from Andonova and Mitchell (2010), the paper conceptualises rescaling as a multidimensional phenomenon and proposes four analytical categories of rescaling: (i) rescaling transnational coordination, (ii) rescaling intergovernmental coordination, (iii) rescaling across issue areas, and (iv) rescaling science-policy interaction.

Findings: The paper shows that spatial, temporal, and institutional problems of fit are inherent to multi-level environmental governance and also characterise climate change adaptation in Switzerland. Further, the proposed analytical categories of rescaling are used to illustrate climate change adaptation policy-making in Switzerland. The paper concludes with the benefits and shortcomings of climate change adaptation policy-making and a call for further empirical research to clarify what represents good practices of rescaling.

Significance for practical solutions: The assessment of rescaling practices has identified several benefits and shortcomings of climate change adaptation policy-making in Switzerland. The benefits include the development of the national climate change adaptation strategy, which has been a multi-stakeholder, cross-sectoral, evidence-based, and science-driven endeavour. The shortcomings are that the process of developing a national climate change adaptation strategy has so far been rather slow, too limited to federal actors, and dominated by some sectors that have sought to use new opportunities to advance their own interests (e.g., agriculture, tourism, energy).



ABSSUB-741

SC 9.5 Governance of social dilemma in adaptation

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Research question: As adaptation moves towards implementation, a focus of the emerging literature is on the barriers to adaptation encountered thereby. Yet while an extensive list of barriers has been developed, there is relatively little theory explaining why they arise and how to overcome them. Many of the most difficult barriers to adaptation arise from the conflicts occurring in the provisioning of nature-related collective goods (defined here as common pool resources and public goods). Examples are under-provisioning of collective climate protection (e.g., dikes, storm shelters, etc.) and overuse of shared resources threatened by climate change. Moreover, climate change directly impacts natural systems and is very likely to make provisioning of these collective goods more urgent and conflicts over the distribution of costs and benefits of provisioning more severe. While a new focus for adaptation research, conflicts arising in collective good provisioning have been extensively studied by commons and natural resource management scholars for decades. Therefore, the research question addressed by this paper is how can the hard-won insights from the commons literature can be usefully applied for understanding conflicts that arise in climate change adaptation?

Methodology: Specifically, we focus on realist-materialist approaches that study how properties of natural systems give rise to specific governance challenges. These approaches are particularly relevant for adaptation, because climate change affects precisely these properties and thus may alter the governance challenges faced. This paper draws on the work of Elinor Ostrom and other realist-materialist commons scholars focusing on the physical properties of natural systems to develop a typology of adaptation governance challenges and, for each type, policy recommendations to address these challenges.

Findings: We find that adaptation governance challenges can be characterised through three key aspects of interdependence between affected actors. First, interdependence between provisioners and beneficiaries of an adaptation measure; second, whether the adaptation good provided is additive or joint; third, whether supply-side or demand-side provisioning is required. We illustrate the resulting typology and associated policy instruments through discussing cases from the adaptation literature on adapting agriculture to increasing water scarcity, adapting to increasing urban flood risks and heat stress and biodiversity conservation. With this approach, we illustrate the salience of the body of accumulated knowledge in the commons literature for identifying adaptation policy instruments.

Significance for practical solutions: These findings are particularly relevant for implementing practical solutions because the types developed here also enable an identification of the conditions under which climate change shifts dilemmas from one type to another. Combined with climate scenarios, this enables identifying points in time when a policy instrument shift is needed.



ABSSUB-1056

SC 9.5 Protecting coastal agriculture in regional Australia by uncovering limits to adaptive capacity

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Research question: Threats to coastal agricultural systems from climate change require governance systems to develop their adaptive capacities to improve resilience. Catchment-based collaborative natural resource governance has been a key approach advocated by the Australian Government over the past two decades to build such adaptive capacities. A high value agricultural system in coastal Australia, the Burnett and Mary river catchment region of Queensland, was studied due to its history of severe episodic flood events. The research examined the regional natural resource governing system to understand deficiencies in governance and factors affecting the building of adaptive capacity.

Methodology: A case study of regional governance in Queensland, Australia, was used to assess current governance arrangement against governance theory and best practice. Data was collected through semi-structured interviews with regional stakeholders across community, agricultural industry and government organisations and verified by state level natural resource experts. Governance and resilience theories provided the basis for a broader framework of analysis. Governance attributes such as flexibility, inclusiveness, equity, sensitivity and various types of capitals were explored. These attributes indicate the level of adaptive capacity of the resource governance systems.

Findings: While the collaborative resource governance model has contributed to enhancing interactions among key players of the governing system, it fails to support adaptive capacity attributes of the governing system sufficient for the system to adapt to adverse impacts of climate change. The reasons for this are twofold: (1) the governability limitations due to properties of the socio-ecological system of the region, and (2) the external factors such as failed neo-liberal policy implementation and strategies of collaborative resource governance approaches. The external factors pose greater impediments for adaptive capacity than the properties of the socio-ecological system of the region. Due to these reasons the regional agri-environmental organisations are incapable of making a significant contribution to building the adaptive capacity of the farming communities in the region.

Significance for practical solutions: Findings from the case study assessed against the governance and resilience theories suggest that mere collaborative regional resource governance approaches are inadequate due to: 1) the absence of a strong meta-governance system supporting conflict resolution and appropriate monitoring and evaluation processes; 2) insufficient investment in building institutional capacities; and, 3) lack of proper policy integration mechanisms. Findings from the governance analysis have important implications for the governability of agri-environmental systems for both developing and developed nations facing climate change threats.



ABSSUB-1320 C9.6

SC 9.6 Climate adaptation and world markets: governance implications of indirect climate impacts

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Research question: Significant resources are being committed to climate change adaptation research and planning, particularly at the national level. Adaptation planning practices have so far often taken a predominantly territorial approach, by assessing direct climate impacts potentially afflicting the jurisdiction's territory. However, countries are increasingly economically interdependent and this influences the nature of vulnerability at all scales, including the transmission of climate impacts across borders and the effects and efficacy of adaptation. As a number of reviews have begun to suggest (Hunt, Watkiss & Horrocks, 2009; Wilby, 2012; Liverman, 2015), current research and practice around adaptation tends to ignore this international dimension of climate risk. This is a serious omission since the cost of indirect climate impacts can amount to up to 30% of total climate impact costs in some economies (Schenker, 2010). As conceptual frameworks for and evidence of indirect climate impacts are now emerging, this paper focuses specifically on governance and policy options. What are key governance and policy options for national governments to adapt to indirect climate impacts?

Methodology: To a large extent, these options and challenges are similar to general options and challenges for national governments operating in a highly economically globalised context, where legal competence is weak and effective international cooperation sometimes lacking. However, we study specifically the options for spending scarce, and ear-marked, climate adaptation funds in vulnerable developing countries. This paper further focuses on indirect impacts on food security and food trade as a case study area. The identification of options will be based on literature review and expert interviews (government policy-makers, IGOs, academics).

Findings: Governance and policy options identified are expected to include: i) re-allocation of a country's 'fair share' of adaptation finance to agricultural investments in key exporting markets, to reduce effects of rising or more volatile food import prices – though it may not be politically acceptable; ii) invest in national self-sufficiency to reduce import dependency – though it may not be efficient; and iii) subsidise instruments to ameliorate price shocks, such as price ceilings, insurance, and financial instruments.

Significance for practical solutions: The identified options, and the issue of understanding and planning for indirect impacts at large, are expected to have high relevance for national adaptation planning, including the UNFCCC NAPs. The issue has already been brought to the NAP community's attention. The significance of this particular paper is that it will explicitly identify options and also conclude by discussing them with regards to effectiveness, equity and political acceptability.



ABSSUB-554

SC 9.6 Does it matter what you call it? Reflections on voluntarily corporate adaptation disclosure

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Research question: This paper provides insights into multinational corporations' adaptation framings in their external communication, and asks what we can learn from corporate adaptation disclosure. It is guided by two research questions:

- 1) How is adaptation conceptualised in current corporate voluntary disclosure?
- 2) How are the companies in the F&B industry showcasing their adaptation action in the reports under the UNFCCC's Private Sector Initiative (PSI) and in their voluntary disclosure?

Methodology: The methodology is qualitative with a case approach. We undertook a literature review and report analysis to address the research questions, and used semi-structured interviews with the UNFCCC and other experts to support the contextualisation of the results. The F&B sector has the highest number of case studies (17) on the PSI database. We focus on the 12 projects that have been undertaken in developing countries. The analysis of the companies' independent reporting is based on longitudinal report analysis on years 2009-2014.

Findings: Our review of literature and the existing evidence base shows that adaptation is considered by the private sector either as 1) risk reduction activities, 2) supply chain management, 3) Corporate Social Responsibility and/or 4) business opportunities. To a large degree, the findings from the PSI analysis of F&B companies reflect these suggestions. F&B MNCs disclose their adaptation action mainly as risk reduction and supply chain management. When it comes to disclosing business value, we find that when risk reduction is linked to opportunities, then engaging to climate change appears to represent a positive investment for companies. Overall, two thirds of the companies indicate business benefits in the PSI. Yet, only one company discloses adaptation specifically as a business strategy. This suggests that a paradigm shift where business opportunities are considered the most concrete framing for adaptation may still be difficult to achieve in reality.

Importantly, we find that apart from business opportunities, the PSI reports do not capture information on how corporations perceive future climate scenarios. Yet, the longitudinal analysis indicates that companies are starting to differentiate their adaptation action between current and future impacts. This divergence between the PSI and annual reporting is critical given that analysing the current-future interface helps reveal where 'business as usual' and disaster risk management approaches differ from forward looking planning.

Significance for practical solutions: This differentiation is also significant for practical adaptation solutions. It gives better baselines for regulators to introduce regulatory mechanisms that facilitate corporate adaptation in the medium and long-term. It would also help companies with their own planning. Moreover, a more transparent disclosure of future climate impacts could also help improve their accountability and relationships with stakeholders, and help avoid the possibility of 'green washing' activities.



ABSSUB-593

SC 9.6 Standards as a form of adaptation governance

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Research question: There are ongoing discussions as to what extent standards can and should be used in adaptation to climate change. The International Organization for Standardization (ISO) has developed a draft document on adaptation standards. The European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) are also putting efforts into developing standards for adaptation. As research on standards for adaptation emerges there is also a discussion as to what aspects of adaptation planning and processes can be in fact standardized. Given that adaptation is often considered to be a technological and financial challenge, most of the emerging work focuses on technical standards related to physical assets. However, adaptation is also about social, political and normative aspects. From this perspective, the procedural and societal components of adaptation could also benefit from standardization. To date there has been limited attention to the role of standards as a form of governance in the adaptation to climate change scientific literature. This paper explores a broad understanding of standardization in relation to adaptation to climate change, and addresses the following research question: What are the potential contributions and limits of standards as a form of adaptation governance?

Methodology: We use a historical and critical social science perspective and a qualitative set of methodologies, exploring lessons from in-depth knowledge of standards development and verification within a broad range of issue areas.

Findings: We find that standards can be a positive contribution to more accountable, efficient, transparent and inclusive adaptation planning and processes. Standards are a private or hybrid form of governance involving multiple institutions and stakeholders, often at multiple scales; they can be local, national, regional or international. Standards could be the result of top down or bottom up processes of standards building and are often complementary governance tools to government regulations.

Significance for practical solutions: Although voluntary in nature, standards can provide infrastructure for scaling up solutions and can enhance innovation. However, the process of developing standards is critical for their legitimacy and potential uptake. Our paper argues that appropriate standard development processes can bring salience, credibility and legitimacy to adaptation planning and more accountable and inclusive adaptation options.



ABSSUB-633

SC 9.6 Intolerable risks of climate change and the debate on loss and damage under the UNFCCC

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Research question: This study addresses the question of how different stakeholders involved in the debate about loss and damage under the UNFCCC conceptualise intolerable risk of climate change. The study also asks how different concepts of intolerable risks might actually be operationalized and how they relate to the risk-based approach to climate change adaptation, including social vulnerability and adaptive capacity. To answer these questions, the study builds on recent research on constraints and limits to adaptation, which describes intolerable risks as risks that threaten to have severe impacts on personal or social norms despite adaptive action.

Given the current lack of ambition in mitigation, it is increasingly likely that such intolerable risks will occur on a wide scale. The question of how to deal with intolerable risks of climate change has also become a key issue for negotiations under the UNFCCC since the establishment of the Warsaw International Mechanism on Loss and Damage (WIM) in 2013.

At the moment, the scientific understanding of intolerable risks of climate change trail far behind discussions about those risks within the UNFCCC. There is an urgent need for scientists and political decision makers to better understand, develop and – where appropriate – apply approaches to address intolerable risks of climate change.

Methodology: The empirical findings of this study are based on a comprehensive literature review of statements and reports published by organisations and parties to the UNFCCC engaged in the debate on loss and damage. The selection of the literature is based on stakeholder analysis. Complimentary interviews have also been conducted with researchers and negotiators that work in connection with the Executive committee of the WIM.

Findings: Findings show that there are large differences in how different actors define intolerable risks particularly in regards to the question if certain impacts of climate change are unavoidable or not. Results also suggest that most concepts of intolerable risks cannot be easily operationalised for political decision making under the WIM.

Significance for practical solutions: Amid the lack of a clear definition of intolerable risks and loss and damage, a contentious debate has started within the UNFCCC about what impacts from climate change are unavoidable and what type of actions are needed, besides adaptation, to respond to and provide redress for these impacts.

This study brings analytical clarity to the discussion about intolerable risk and loss and damage, by unpacking some of the conceptual issues and relationships. It informs organisations and parties to the UNFCCC, particular stakeholders of the WIM, about the conceptual limitations and operational value of different approaches to intolerable risks and makes recommendations for future research in this area.



ABSSUB-881

SC 9.6 We now have sustainable development goals; should we also have adaptation goals?

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Research question: Last year the UN agreed to a set of Sustainable Development Goals (SDGs) to address the broad challenges of poverty eradication, environmental protection and sustainable consumption and production. They make only limited mention of climate change issues and specifically to adaptation. At the same time in the UNFCCC negotiations there have been increasing calls, mostly from developing countries, for an adaptation goal (or goals) to be set to provide a similar focus as the mitigation goal of maintaining global average temperature increases to within 2 degrees C. Are adaptation goals feasible and compatible with the SDGs?

Methodology: Different types of adaptation goals have been suggested (qualitative versus quantitative; nationally or regionally specific; etc.) and different criteria for judging the effectiveness of designing, agreeing to and implementing adaptation goals. A goal is likely to be of little value unless progress towards it can be measured. I will draw upon experience in deriving metrics for vulnerability to climate risks and capacities to deal with them, and from lessons from the Millennium Development Goals and other development indicators, to address the question of measuring progress.

Findings: I conclude that quantitative and qualitative indicators of aspects of the adaptation process can be found and demonstrated to be effective. However, there is little agreement as to what aspects are the most important (i.e. which indicators to use), and there will be problems with data availability and in the responsiveness of the indicators (i.e. how long they will take to show a change). Also adaptation and development are intricately linked and probably cannot, and should not, be separated. So should adaptation goals be a subset of the SDGs?

Significance for practical solutions: The development of adaptation goals is a challenge that will require the collaboration of the scientific, development and negotiating communities. The debate that will be required to establish whether adaptation goals should and can be agreed and whether they can be implemented, will in itself lead to many of the benefits of actually having adaptation goals; namely, raising the profile of adaptation in tackling climate change, and asking what we want in a world where development is sustainable and climate resilient.

ABSSUB-832

SC 9.7 The political economy of climate change induced resettlement

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Research question: Climate change is likely to render some human settlements uninhabitable. As the impacts of climate change become more pronounced, more people in more places will need to consider how to best adapt to impacts. Whilst in-situ adaptation options may be feasible in most cases, there will be cases in



which resettlement may be the only viable option for communities. In these instances it is important that we understand how best to support those communities. Historically resettlements, be it induced by development projects or through environmental displacement, have tended to further impoverish and marginalise affected communities. There is no reason to suggest that resettlement as a result of climate change adaptation will be any different and yet there remains an optimism about adaptation programmes in supporting vulnerable communities. As part of a broader research project on adaptation and mobility in deltaic environments (Deltas, Vulnerability and Climate Change: Migration and Adaptation), this paper examines the political economy of climate change induced resettlement and its impacts on three vulnerable communities in Ghana, Bangladesh and India. The case studies demonstrate how political agendas permeate adaptation projects and the need for a critical gaze on how adaptation is performed and who stands to benefit.

Methodology: The paper will present findings from 30 qualitative interviews with government officials and local opinion leaders from each of the case studies, combined with document and policy analysis.

Findings: The findings demonstrate the political nature of adaptation decision-making and how communities and community members are marginalised through the process of resettlement, in the name of adaptation. The findings also demonstrate significant governance barriers to adaptation that shape resettlement processes and outcomes for the affected communities.

Significance for practical solutions: The findings of this research are significant for adaptation decision-making. The paper will present principles to guide decisions on when resettlement is appropriate, and to guide governance processes of climate change induced resettlement so as to maximise positive outcomes and to minimise harm for affected communities.

ABSSUB-612

SC 9.7 Private sector involvement in urban adaptation planning: exploring the role of property developers

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Research question: It is increasingly recognized that managing climate change, as well as facilitating wider processes of societal transformation, require the engagement and coordinated responses of both public and private actors. Private actors are in this sense expected to play critical roles as potential entrepreneurs and/or leaders in managing climate risks (Bulkeley, 2010; Agrawala et al., 2011; Tompkins & Eakin, 2012; Taylor et al., 2012; Mees et al., 2012; 2013; Juhola, 2013; Bauer & Steurer, 2014). The presentation will zoom in on the role of private property developers in Swedish urban planning for climate change. The property development industry is portrayed as having considerable financial, political or technical resources (Taylor et al., 2012) that assumedly can foster innovative practices to improve urban resilience to climate change (Agrawala et al., 2011). The presentation aims to contribute to the call for further studies to increase our empirical understanding of the position, perspective and roles of private actors in governing climate change thus exploring how roles are perceived, to what extent capacities are enacted and what delimits or enables an increased public-private interplay.

Methodology: The presentation builds on a Swedish case-study of urban planning the city of Karlstad. Karlstad is situated in the river Klarälven delta at the shore of the big lake Vänern in the Mid West Sweden.



The study builds on qualitative interview methodology in the form of two focus-group interviews with a total of 13 municipal officials spanning different mandates and tasks in urban planning and 7 semi-structured individual interviews with property developers.

Findings: The presentation elaborates on empirical findings discussing the challenges of: 1. Simultaneously meeting public, private and customer demands in urban planning, 2. Regulative versus collaborative public-private interplay, and 3. Property developers taking on a more proactive role in managing climate change. On the one hand, it is suggested in interviews that increased public demand ensures the implementation of local climate goals and ambitions. On the other hand, it is also suggested that these demands are under negotiation in local development planning suggesting that municipalities tend to comply with demands from private developers. The question is how to combine regulative demands and collaboration in public-private interplay. The interviews with property developers also show weak incentives of taking the lead in fostering new, innovative practices for climate considerations in urban planning.

Significance for practical solutions: Increasing knowledge of the role private actors e.g. property developers can play in adapting to climate risks and how public-private interplay can be strengthened in urban planning is an urgent task in assessing the potential and challenges of new governance options.

ABSSUB-823

SC 9.7 Parliamentary actions in South Asia on climate change adaptation: successes and challenges

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Research question: Renewable Energy is a key to the adaptation, especially for developing countries like India and Bangladesh, who are particularly vulnerable to climate change. When countries are focusing increasingly on how to continue social and economic development in the face of an already changing climate, renewable energy can contribute significantly. Parliamentarians of India and Bangladesh, in the recent past, have taken some initiatives through policy interventions, legislation-making and budget oversight to develop synergies between distributed renewable energy systems and adaptation efforts, with renewable energy development providing both development benefits and adaptation services. The presentation will build a case for the parliamentary actions by giving successful examples where the countries already dealing with the impacts of a changing climate, adaptation and development are not necessarily mutually exclusive. Parliamentary initiatives in clean energy development can provide benefits towards both goals.

Methodology: The Presentation will adopt an approach of case study, interviews, secondary/primary literature review and will draw out concrete conclusions.

The case study will focus on Climate Parliament network of Parliamentarian and legislatures, dedicated towards preventing climate change and promoting renewable energy. In South Asia, Climate Parliament MPs are concentrating their efforts on most populous developing countries in the world – India and Bangladesh. The Parliamentary and legislative interventions on adaptation will be located primarily in the realm of energy access and clean energy, natural disasters and agriculture, water scarcity, drought and famine.

The presentation will focus on 1. Forming a Climate Parliament Group in the national Parliament or state Assembly in India and Bangladesh and their striking achievements 2. Maintaining the steady pressure on the



Governments by the MPs working day by day to question Ministers, introduce policy ideas, hold committee hearings, and propose budget amendments 3. Initiating regional cooperation

Findings: By studying Parliament and Parliamentarians, the presentation will establish that the elected legislators are the one group of people in the world who have all the levers they need to solve the climate problem. They vote on laws, taxes and budgets, oversee the operations of government, and have direct access to Ministers, Prime Ministers and Presidents. They can have a major impact on policy and legislation for climate change adaptation.

Significance for practical solutions: Working towards creating an enabling policy, legislation, institutional and budgetary framework through parliamentary actions will provide valuable information and knowledge to other developing countries in addressing climate change and in achieving progress towards national sustainable development goals and objectives. This will strengthen climate governance by mainstreaming climate change into a number of key sector policies in energy, water, agriculture and rural development.

ABSSUB-516

SC 9.7 Development implications of assessing loss and damage in the Philippines

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Research question: What is the state of loss and damage assessment system in the Philippines and how can we link loss and damage with climate change adaptation and disaster risk reduction?

Methodology: The study employed review of literature and focus group discussions and key information interviews with key experts on L&D, CCA, and DRR. Fifty-eight (58) science and policy experts and representatives from various national government agencies, local government units, non-governmental organisations, research organisations, and other relevant stakeholders were also convened in a form of a national workshop to discuss gaps, challenges, and opportunities in linking L&D with CCA and DRR in the Philippines.

Findings: The state of L&D assessment system in the Philippines is still on its formative stage with a loose structure. The system is faced with challenges on standardization, data needs, capacity building, partnership, and governance. These should be addressed in order to have a stronger and efficient system with smooth process. Various government agencies and relevant stakeholders recognized the essence and relevance of using L&D information, especially for planning and development. Respondents acknowledged that L&D information could be used to improve existing CCA and DRR strategies. However, there were some issues on the integration of CCA and DRR that must be tackled. In order to fully utilize L&D information for planning and improvement of CCA and DRR strategies, proper and guided actions must be undertaken and the above-mentioned five challenges must be addressed to fill the existing gaps.

Significance for practical solutions: The study is significant to policy makers as a guide for planning, governance and operations in the event of disasters. The following are the recommended actions from the government and other relevant stakeholders based from the results of the study: (1) prioritize continuous discourse on standardization, data needs, capacity building, partnership, and governance for collaborative



action and inclusive progress; (2) consider the application of the holistic approach to L&D assessment from the planning up to the evaluation of policies and programmes; and (3) promote the optimal use of L&D information to improve CCA and DRR strategies.

ABSSUB-871

SC 9.7 Challenges smallholder farmers face in accessing institutional support in rural Ghana

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Research question: Smallholder farmers in sub-Saharan Africa have been documented as one economic group that is most susceptible to climate change due to their reliance on the weather, low adaptive capacities among others. This therefore makes institutional support to adaptation very important as they can ensure the sustainability of farmers work through their control of resources, behaviour and power. This study sought to find out the problems smallholder farmers faced in accessing institutional support to address climate change in rural Ghana, using the Sissala East and West Districts as cases. Enquiries were made on challenges institutions faced in providing adaptation support to smallholder farmers while factors that hindered smallholder farmers from accessing institutional support were examined

Methodology: A survey was conducted for 160 heads of farming households randomly selected from both districts. Face to face interviews were organised with 12 heads of institutions involved in agricultural development in the study districts. Selection of institutions was initially purposive but the snowball technique was adopted as the study progressed. The chi-square test was used to test for the significance of age and gender to access to institutional support.

Findings: Research findings indicate that, there is no influence of gender on access to institutional support in study area even though various interventions were targeted at women farmers. Farmers cited insufficient information on the existence and activities of institutions in adaptation in the districts. Language barriers between farmers and institutional representatives, and the low educational level of farmers causing their low self-esteem were mentioned as factors which hindered farmers from accessing institutional support. Institutions also stated financial constraints, lack of personnel and lack of commitment from farmers to access available support as issues that affected their efforts towards smallholder farmer adaptation.

Significance for practical solutions: Although the study findings indicated contrary to earlier studies that there is no influence of gender on access to institutional support in the study area, this could be attributed to the low turnout of women in the study. This is because women in Northern Ghana had to receive male consent before speaking to non-community members or males.

Again, issues relating to language barriers between institutions-farmers and financial constraints tend to affect the sustainability of climate change projects as most climate change projects tend to "die" when the project ends.



ABSSUB-414

SC9.8 Redesigning governance using the adaptive capacity wheel in Canada, Chile and Argentina

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Research question: Drought and floods are likely to cause havoc in different parts of the world. This paper analyses the adaptive capacity of two provinces in Canada (Alberta and Saskatchewan) and Coquimbo, Chile, and Mendoza, Argentina in dealing with droughts and floods. It answers the research question: What policy instruments improve the adaptive capacity dimensions of governance for agricultural producers responding to climate change, drought and flood?

Methodology: The case study areas are all rural agricultural areas with significant irrigation, are experiencing similar climate change impacts (increasing frequency and duration of drought, warmer temperatures, and longer growing seasons), but have significantly different governance structures. After reviewing previous studies, performing a content analysis of institutions (organizations, laws, regulations, policies) relating to climate change, drought and flood and coding for dimensions of institutional adaptive capacity, semi-structured qualitative interviews were conducted with key policy stakeholders in each case study area exploring the dimensions of institutional adaptive capacity. This paper uses the Adaptive Capacity Wheel to assess the adaptive capacity of the institutions in each case study areas. This paper exposes weak institutional dimensions and corresponding absent or ineffective policy instruments. A comparison of the case studies offers insights into specific institutional practices and policy instruments that strengthen institutional response in the developed country provinces of Canada and the developing country provinces of Argentina and Chile. Key instruments are identified as well as institutional practices that resulted in significant double loop (questioning mental models underpinning strategies and action) and triple loop social learning (changing values and norms leading to a deeper understanding of inter-relationships of people and nature).

Findings: Based on this research, recommendations are made for contextual institutional governance redesign. Certain economic instruments (crop insurance, financing, disaster assistance) are important for adaptation through new practices and technologies (single loop learning); significant policy tools are required for double loop learning (irrigation projects and upgrades). However, for triple loop learning sustained, iterative, participatory instruments are required.

Significance for practical solutions: This research is significant as it identifies specific policies and characteristics of governance systems that will build adaptive capacity of agricultural producers.



ABSSUB-729

SC 9.8 Governing coastal disaster risk reduction in Indonesia and India

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Research question: The coastal area is prone to disasters especially due to its dynamics and complexity. The problem of climate change is also raising the level of unpredictability of coastal areas in terms of increasing the magnitude and frequency of disaster events. Technological and engineering approaches dominate the response strategies. However, there is lack of research scrutinizing the socio-political aspects of nation to micro level governance. Such research is necessary to address the reality of reduced state power and the emerging diversity of actors including private sector and civil society in governing coastal disaster risk. This study is aiming to address research questions on governance aspects of coastal disaster risk reduction projects. The overarching question of this research is "how does governance interaction contribute to the successful disaster risk reduction in the coastal area?"

Methodology: This complex question will be answered by conducting comparative research between analysing coastal erosion risk management in Demak in Indonesia and reducing the risks of storm surges and tsunamis in Pichavaram, Tamil Nadu in India.

Findings: The method includes: (1) Identification of the main type of coastal disaster in India and Indonesia; (2) Examination of the existing application of the governance of coastal DRR concept in Indonesia and India; (3) Elaboration of governance interaction with regard to coastal DRR in Indonesia and India, and (4) Comparison of Indian and Indonesian case studies.

Significance for practical solutions: This paper tries to contribute to the theoretical analysis of governance and disaster risk reduction by examining the relevance of "pure" green approaches such as by using only mangrove ecosystems or "grey" infrastructural approaches, or hybrid approaches by combining ecosystem-based and concrete-based measures such as sea wall and dikes.

The paper will try to also make concrete recommendations for adaptation options in the global south.



ABSSUB-533

SC 9.8 Urban climate adaptation, infrastructure planning, and socio-spatial (in)justice in the global south

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Research question: Recent developments in urban climate change adaptation theory and practice focus on how cities can downscale climate data into local plans, address impacts through spatial design and infrastructure interventions, and obtain political leadership, commitment, and financing to implement such plans. Adaptation plans should reduce the vulnerability of the poor – particularly those in the global South – who have contributed the least to climate change but are often disproportionately exposed to its impacts. However current research has not adequately assessed: how are different plans prioritising the vulnerability of marginalized communities and how are these plans reducing, exacerbating, or creating new socio-spatial injustices in cities?

Methodology: In response, this paper begins with a discussion of how urban climate adaptation is theorized at the nexus of urban governance, environmental justice, and infrastructure and spatial planning. Then, using this framework, we analyse two sets of empirical evidence to assess how emerging urban plans are implicating issues of climate justice. First, we survey emblematic spatial adaptation plans, redevelopment interventions, and infrastructure investments in cities across India, Indonesia, South Africa, Colombia, and Ecuador. Then, we provide qualitative case studies of on-the-ground adaptation experiences in the cities of Surat (India) and Medellín (Colombia).

Findings: From our survey of emblematic spatial adaptation plans, redevelopment interventions, and infrastructure investments in cities, we highlight global patterns of urban marginalization, displacement, and climate gentrification. Then, in our case studies of Surat (India) and Medellín (Colombia), we show how recent adaptation interventions have been co-opted by private interests, leading to neighbourhood destruction, decreasing access to basic services, and exclusion of vulnerable communities from decision-making processes.

Significance for practical solutions: We conclude the paper by arguing that, in order to facilitate just socio-spatial adaptation pathways in cities, scholars and policymakers must be cognizant of how the pressures and conditions of a globalizing economy, entrepreneurial urbanism, urban competition, and unequal spatial development shape cities' spatial planning strategies for climate adaptation.



ABSSUB-804

SC 9.10 European policy objectives – Implications for decision-making under high-end climate change

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Research question: This work is part of the FP7 IMPRESSIONS research project, which aims to provide empirically-grounded science that quantifies and explains the consequences of high-end climate change (i.e. beyond the 2 degrees target) for society at large, and which is particularly useful for decision-makers with responsibilities in the design of climate-related strategies. The objective of this paper is to improve the understanding of how adaptation-related decision-making processes occur in the context of European policies. Its focus is on multi-sectoral impacts and possible policy responses to high-end climate change within several sectors, including water, land use, forestry and agriculture. In this presentation we explore the research question: What are the critical information needs and capacities of European decision-makers for developing adaptation policy and practice regarding the consequences of high-end climate change scenarios for selected current European policies?

Methodology: The paper will present results from in-depth interviews with decision-makers from three EU institutions: the European Commission, the European Environmental Agency and the European Parliament. The scope of the work is defined by five EU policies: Water Framework Directive, Floods Directive, Habitats Directive, Common Agriculture Policy, and Forestry Strategy. Model-based indicators from the IMPRESSIONS Regional Integrated Assessment Model (rIAM) were linked to European policy objectives to highlight the multi-sectoral implications of climate impacts in light of high-end climate change. The interviews sought to identify the critical needs and capacities of European decision-makers in considering high-end climate change scenarios, in the development of adaptation policy and practice.

Findings: The paper finds that, to a large extent, European decision-makers do not currently consider high-end climate change in their decision-making related to EU policies. The paper also finds that the key policies of each EU policy will potentially need to be modified in light of possible high-end climate change scenarios. Particularly, systemic effects with relation to critical thresholds across multiple sectors need to be taken into consideration. It further highlights the role of model-based indicators in quantifying thresholds for EU policies and their alignment with potential high-end climate change.

Significance for practical solutions: This work has been undertaken together with decision-makers operating at the EU level. The findings are being used to support future decision-making in light of high-end climate change within several sectors as well to enhance the understanding of cross-sectoral implications.



ABSSUB-1021

SC 9.10 On integrating high-end scenarios into real-world adaptation decision-making in Portugal

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Research question: The Tagus river basin is one of the five international river basins shared between Portugal and Spain and is among the European basins most likely to be affected by droughts if High-End Climate Change scenarios are realised. Water scarcity is also likely to be aggravated by the traditional focus on irrigation and large-scale water transfers. Under such scenarios, decision-makers will be faced with greater water-resource management challenges. Sectors such as water supply, agriculture, energy, and nature conservation along the river course may become more vulnerable in relation to activities carried out upstream.

Methodology: This work is part of the FP7 IMPRESSIONS project. Results of in-depth interviews with Portuguese public and private decision-makers involved in adaptation-relevant decision-making processes within the above mentioned sectors will be presented. This work intends to improve the understanding of the decision-makers current capacities, barriers and drivers to integrate climate change, and in particular high-end scenarios (HES), into real-world decision-making processes. Furthermore, we explore what are the critical knowledge needs and the conditions and processes enabling the development and implementation of integrated solutions aligned with sustainable pathways to cope with HES.

Findings: Although there is a high level of awareness about climate change and its' impacts, information about scenarios have not been systematically applied to sectorial or cross-sectoral decision-making processes. One of the most frequently cited reasons for these was that most decision-making processes are designed to operate within fairly short consequence times.

Most interviewees acknowledged that the decision-making processes in which they are involved would benefit from a more systematic integration of climate change scenarios. Nevertheless, they consider that their institutions' strategies and plans already include robust adaptation measures that could potentially suffice even under HES. Thus, they are not currently considering transformative options, even under HES, although also not discarding them. However, already planned (incremental) measures may need to be implemented earlier than expected, and enhancing monitoring schemes is seen as important in order to maintain flexibility. Uncertainty is generally not considered as a strong impediment for decision-making although HES themselves are recognized as a potential additional challenge.

Significance for practical solutions: This work has been undertaken together with Portuguese decision-makers operating at the national and local levels. The findings are being used to support future decision-making in light of high-end climate change within several sectors as well as to enhance the understanding of cross-sectoral implications nationwide and in the Tagus River basin in particular.



ABSSUB-1199

SC 9.10 Transition stacking: stakeholder perspectives on vulnerability and adaptation in rural Hungary

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Research question: Countries with memories of recent or ongoing transitions are increasingly facing new needs to confront the impacts and vulnerabilities arising from climate change, as one of the dimensions of global change. Understanding the interactions between earlier transition experiences and the need for socio-ecological adaptation from the perspective of stakeholders on the frontline can provide important empirical information on the possible conflicts, synergies and learning opportunities that may arise on this interface.

Methodology: This research involved collecting stakeholder perspectives on vulnerability and adaptation in two rural towns in Hungary. Interviewees were selected through stakeholder mapping and snowball sampling, and focused mainly on municipal services and the agriculture sector, with emphasis on the following: characterisation of the decision-maker and decision-making context; the objectives of decision-making; adaptation-related decision support; and decision-making outcomes.

Findings: The research revealed that the perception of climate-change related vulnerability is viewed through a lens of broader socio-economic transitions where institutional, financial and capacity limitations are dominant considerations. There are indications of strong cross-scale dependencies, but also interest in developing autonomous capacity to cope with and adapt to climate change, building on time-tested methods and novel approaches.

Significance for practical solutions: At the conceptual level, this research provides a starting point for deeper inquiries into the learning opportunities between transition experiences and adaptation needs, both in the transition economy context but also beyond. 'Transition stacking' as a new concept will be defined and its possible implications for adaptation research discussed. At the practical level, the results will feed into the construction of context-specific high-end integrated climate change scenarios and models, and the elaboration and assessment of associated adaptation options.



ABSSUB-641

SC 9.10 Exploring decision making related to risks posed by high-end climate change: IMPRESSIONS Scotland

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Research question: The current emissions trajectory suggests to the scientific community that high-end climate change scenarios are a serious potential hazard. Although high-end climate change scenarios continue to be viewed by the scientific community as lower probability than other scenarios, the issue remains that the potential for high-end climate change scenarios to eventuate poses high risk because of the magnitude of the hazard.

Is the magnitude and likelihood of this hazard common knowledge for stakeholders who will be on the front line of these potential impacts? And if so, are they acting to adapt in line with the high-end impacts? Or do they consider only more moderate scenarios of change? This study presents evidence from a land resource management case study in Scotland – part of the IMPRESSIONS project – to provide insight into stakeholders' knowledge and decision making related to the risks posed by high-end climate change scenarios.

Methodology: Results from in-depth interviews conducted with decision-makers within land resource management sectors in Scotland, including forestry, agriculture and tourism, are used to support existing ideas from the literature about uncertainty, non-climate drivers, and tailoring climate change information, and to extend these ideas to application for high-end climate change scenarios. The interviews focused on the individual, behavioural and institutional conditions and decision-making processes that underpin adaptation. They included exploration with stakeholders of the need for transformative strategies to deal with high-end scenarios.

Findings: Key themes which are supported by the evidence from the interviews indicate that:

- Uncertainty is not a significant barrier for decision making – as parts of the scientific community continue to believe – but that qualitative descriptions of uncertainty are and can be more usefully employed by these decision-makers than quantitative descriptions;
- Non-climate drivers are at least as important, and in many cases more important, than climate drivers when it comes to adaptation decision making; and
- There is no need for more climate change information to support the adaptation decision-making of these stakeholders – because more information does not fix the inherent uncertainty of the information – but there is need for more information about the implications of particular sectoral and cross-sectoral impacts.

Significance for practical solutions: This work is co-produced with decision makers. The findings are being used to support adaptation strategies of decision makers within the land resource management sectors in Scotland; and more broadly should be used to provide evidence to assist with contextualising and creating more usable climate change information.



ABSSUB-1028

SC 9.11 Understanding barriers and drivers of coastal protection at the German Baltic Sea coast

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Research question: In the German federal state of Schleswig-Holstein, bordering both the Baltic and North Sea, approx. one quarter of the territory is prone to storm surge flooding. There is some evidence that the intensity of storm surges may have increased in recent decades and sea-level rise is expected to further raise surge levels. While the vulnerable lowlands along the North Sea coast are protected by dikes built and maintained by the government (state dikes), only few communities of the densely populated Baltic Sea coast are safeguarded by state dikes. Some of these communities have managed to protect themselves through self-financed "regional dikes" and other measures such as groynes or beach nourishment. Many communities, however, struggle to provide coastal protection. This raises the research question of what drives and constrains both the top-down provisioning of state dikes as well as the bottom-up self-protection by local communities at the Baltic Sea coast in Schleswig-Holstein?

Methodology: We conduct an institutional analysis in the form of comparative case studies in several Baltic Sea communities with differing forms of coastal protection (e.g. state versus regional dikes). As coastal adaptation measures generally have public good character, the cases are analysed through the lens of common pool resource and public good theory, which help understand public good provisioning. Data is collected through expert interviews with public and private stakeholders at state and community levels as well as a review of socio-economic data of selected administrative districts along the North and Baltic Sea coast.

Findings: Initial findings point to various governance challenges. Rules for the distribution of federal funds and responsibilities are not clearly defined in the master plan for coastal protection ("Generalplan Küstenschutz"), nor strictly followed in practice. According to the plan, the state is only responsible for measures being "in the public interest" ("to protect the lives of people and extraordinary assets"). However, the well defended North Sea coast is characterised by lower population density. Also, "beneficiaries are responsible for coastal protection", but so far private stakeholders are not held responsible and resource-poor communities cannot shoulder the costs alone. We also find that there is lack of cooperation between communities and that strategies vary greatly. For example, some communities jointly establish water and land associations with the mandate of providing coastal protection more efficiently.

Significance for practical solutions: These findings are practically relevant for the communities studied because they may help under-protected communities to overcome barriers in the self-organisation of coastal protection taking into account the specific institutional, including administrative, context in which coastal adaptation takes place. Furthermore, these findings may also help the state government in designing policy instruments that incentivise local communities to take action.



ABSSUB-1099

SC 9.11 Institutional adaptations in Dutch and American flood governance: the expert-politics nexus

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Research question: Flood risks are changing due to climate change. These changes impact on existing institutional structures in flood governance. That is, changed flood risks influence how the problem of floods is perceived within societies, which in turn influences and how societies respond to flood risks through policy frameworks. This paper aims to better understand how institutional frameworks adapt to increased risks in flood governance. It does so by focusing on the relationship between experts and political actors as one of the key drivers behind institutional change in this domain. It asks: How has climate change impacted on the relationship between experts and political actors flood governance and how has this influenced the institutional framework for dealing with floods in both countries?

Methodology: Empirically, this paper comparatively studies the (changed) relationship between experts and political actors in the Netherlands and in the United States (US), as flood governance in both countries is characterised by two standard but different governance approaches underpinned by the involvement of different types of experts. In the Netherlands, engineers have led a "defense approach" whereas in the US, geographers have guided the development of a "spatial approach" to floods. It studies how these historically grown relationships between experts and political actors changed in the context of climate change.

Findings: The paper finds both in the Netherlands and in the US, the anthropogenic nature of flood risks is emphasized more often; not only are causes of floods are increasingly linked to "irrational" location and building choices in floodplains, responsibilities of floodplain occupants for anticipating floods and dealing with their consequences are also increasingly highlighted. For this reason, "spatial" measures, which call for a more decentralized approach to flood governance, become an attractive response strategy to climate change. The paper also finds that the implementation of spatial measures in Dutch and American flood governance progresses through a very different path, due to differences in the historically grown relationship between experts and political actors in both national contexts. It concludes by discussing some of the new requirements spatial measures place on the relationship between experts and political actors in these specific contexts.

Significance for practical solutions: The insights developed in this paper can help policy makers to come to a better understanding of the institutional challenges involved with adapting to climate change in flood governance. By focusing on the relationship between experts and political actors, the paper not only identifies new requirements for expertise to support spatial measures in flood governance, it also highlights the importance of developing this expertise within the broader context of historically grown institutional structures in order to deal with context-specific challenges and utilize context-specific opportunities.



ABSSUB-1218

SC 9.11 Adapting institutions: exploring climate adaptation through integrative & segregative institutions

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Research question: This paper looks at climate adaptation from the perspective of institutional economics. It focuses on local administrations and explore their role as bureaucratic organisations dealing with nature-related systems, where a changing climate creates new interdependencies. The central question is under which circumstances such adaptation takes place in a coordinated fashion, as opposed to adaptation by individual administrative units within their respective competences.

Methodology: Applying the concept of integrative vs. segregative institutions, the paper draws evidence from 19 climate sensitive municipalities on the Rhine and on the North Sea coast, in Germany. Interview-based case studies are analysed comparatively through a qualitative comparative analysis (QCA) in order to address the nexus between the characteristics of each municipality's coordination structures and the emergence of adaptation processes.

Findings: The analysis shows that adaptation processes can both happen within existing institutions and as a process of institutional change, changing existing institutions. It finds that, while the latter type of adaptation process cannot be explained in organisational terms, the former is linked to the presence of extensive coordination structures. In summary, integrative institutions constitute a sufficient but not necessary condition for "integrative adaptation".

Significance for practical solutions: State administrations intending to avoid additional, climate-related burdens for citizens and conflicts among resource users caused by poorly coordinated adaptation efforts may hence do so by providing local administrations with means for additional coordination, stimulating the creation of integrative institutions. As the data shows, such institutions do not and will not emerge as a functional response to a need for increased coordination. However, whenever they are available, they are deemed capable of addressing the coordination needs of climate adaptation.

ABSSUB-731

SC 9.11 Leveraging private finance for coastal adaptation

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Research question: While extreme sea-level events such as storm surges and tropical cyclones already threaten many urbanised areas around the world and are expected to become more frequent with climatic change, coastal protection and adaptation is under-financed. This is surprising, because investing in coastal protection and adaptation is found to be efficient in many coastal areas, particularly where concentrations of assets are high (Hinkel et al., 2014; Stive et al., 2011). Despite this, public and private sector finance for adaptation in coastal areas has been slow to materialise and hence the question arises what explains this lack



of finance, and how can scarce public funds be used to leverage increased private investment in adaptation?

Methodology: To address these questions, we develop an overview of the coastal adaptation finance landscape, reviewing financial instruments, (potential) investors, and investees. We describe prominent financial instruments in the adaptation space including (green) bonds, equity and other instruments. We classify investors by motivations and mandates, and identifying which investors might be interested in coastal adaptation investments due to the long-time horizons of investments and public good aspects. Following Williamson's transaction cost approach, we then analyse the alignment between financial instruments preferred by investors and characteristics of adaptation projects.

Findings: We find that bonds are not well-suited to adaptation projects whose returns often come after several decades. Equity investments would be more appropriate. The implication is that there is a substantial role for the public sector funds to improve alignment between adaptation projects and large-scale investor preferences for highly liquid investments and thus to leverage private sector investments in adaptation. Our analysis provides a theoretical explanation for the lack of private adaptation finance observed in coastal areas. Moreover, we find that new financial instruments such as public-private-partnerships may improve this alignment. However, these must be designed with attention to the specific characteristics of adaptation project in question and the institutional endowment of the national context in which they take place.

Significance for practical solutions: These findings are particularly relevant for informing practical solutions to overcome financial barriers to implementing coastal protection and adaptation solutions. The analysis presented in this paper will inform further development in the upcoming EC-funded GREEN-WIN project, which aims to foster green and social small and medium sized enterprises (SME) and impact investment in order advance opportunities for green growth and win-win climate strategies.

ABSSUB-1026

SC 9.12 Adapting to risk under austerity in Europe: Greek and Italian cases

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Research question: How has European austerity impacted on the adaptive capacity of coastal Mediterranean communities in Greece and Italy? Vulnerability to coastal extremes is a product of hazard exposure, susceptibility to harm and adaptive capacity. Each element is potentially impacted by austerity. Economic contraction may slow down economic development or leave fewer residents and tourists at risk. Retrenchment in the public sector can undermine planned infrastructure works and freeze capacity. Economic Stimulus Funds may however offer scope for adaptation and risk reduction. The paper is interested in the local governance contexts and strategies deployed during this period and consequences for adaptation.

Methodology: Results are part of a European Commission funded FP7 project: PEARL. Specific methodologies deployed in this part of the project's work included desk reviews of legislation, policy development and budgeting and local media reports; semi-structured interviews with managers in at risk locations, national ministries and in European agencies. Study locations being reported on in this presentation are Rethymno, Crete and Genoa, Italy. Methods were participatory and included much discussion and framing of research questions with local actors. They also are an example of the FORIM methodology designed by IRDR and feed into a review of this method for identifying risk root causes.



Findings: While austerity is felt locally - with significant retrenchment and downscaling of local government capacity, the impacts of austerity are less clear cut. In Rethymno exposure is contained with a rapid coastal development driven by tourism and pushing at the limits of local flood risk management and sanitation capacity, being stalled. Counter intuitively the political space opened by austerity in Crete has renewed political engagement and generated a more active local risk management sector. In Genova anti-corruption legislation has been a barrier to accessing and spending resources earmarked for risk reduction making funds vulnerable to reduction under austerity. In summary local governance issues and strategies seem as or more important than structural changes brought by austerity at the European and national levels - for adaptive capacity and action.

Significance for practical solutions: Understanding the impact of austerity is important for local actors seeking strategies through this period of European development. It is important that stakeholders at all levels are able to ascribe challenges correctly and so reveal opportunities for adaptation even under conditions of financial constraint. It seems unlikely that austerity will end in the near term so this has wide implications for future as well as present risk planning.

ABSSUB-1036

SC 9.12 Understanding adaptive capacity in contrasting risk management regimes

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Research question: As climate change intensifies and accelerates the capacity to cope with impacts and the ability to adapt to opportunities will become critical attributes, to not only recognise but also augment where possible, across multiple sectors and organisations. Adaptive capacity is shaped not only by the ability to mobilize scarce resources to anticipate or respond to perceived or existing changes but also by the operating environment within which risk management actors must function. Since organisations are primary actors in driving and implementing societal responses to climate change, and understanding how organisations are likely to act is fundamental to understanding potential outcomes, this study focuses on the adaptive capacity of organisations within the environmental risk landscape, acknowledging that the range of organisations and values with a role to play in adaptation, and the asymmetry in power relations and governance regimes, is large. This paper draws from the initial findings of a three year study Metropole funded by The Belmont Forum, NERC, NSF and FAPESP. We work with three partners across three at-risk cities on three continents.

Methodology: The paper brings together analysis of adaptive capacity and governance systems in Selsey, UK, Broward County, USA, and Santos, Brazil using the Adaptive Capacity Index (Pelling and Zaidi, 2013) as the fundamental methodological approach. The Adaptive Capacity Index (ACI) is actor-centric and incorporates the influence of structure and agency as defining characteristics in an attempt to move the discussion away from simply measurement into a more practical niche where the study of adaptive capacity can be used as a stepping stone for action at a range of scales. Through the empowerment of actors, the framework creates an actor-identified solutions mechanism through social learning upon which to create pro-active change in how climate change issues are addressed

Findings: This paper presents a comparative analysis of three case study sites in UK, US and Brazil, demonstrating how different elements of adaptive capacity are expressed or suppressed through internal and



external governance forces highlighting barriers and the trade-offs surrounding potential initiatives for effective adaptive management at a local scale.

Significance for practical solutions: The aim of this research is to supply organisations with better understanding on elements of adaptive capacity that can enable them to go beyond raising awareness and, instead, to undertake efforts that will lead to the implementation of practically focused adaptation actions and decisions. By involving a wide range of risk managers and practitioners with a both a macro and local level of understanding, experience and influence the results will contrast existing political economy, wider institutional contexts and the organisational landscape within which decisions must be made while also providing adaptive capacity profiles to assist in this transition.

ABSSUB-1160

SC 9.12 Opportunities for and challenges to social Learning in community response to flood hazards

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Research question: What are the enabling factors for social learning in the case study?

Who are the key stakeholders involved in the social network and how do they shape a potential learning platform for community response and adaptation to flood hazards?

Methodology: Based on a literature review and in-depth interviews with 28 local stakeholders as well as a series of participatory observations of meetings of the Morpeth Flood Action Group (MFAG), we identify and analyse various elements of, and opportunities for, social learning that are manifest in the everyday work of MFAG.

Findings: The findings point to several promising organisational attributes that appear conducive to social learning processes: social network across scales, leadership, institutional development through bottom-up process, and opportunities for collaborative learning over time. In particular, local opinion leaders appeared to be influential for the collective response capacity in terms of mobilising and engaging local people. These individuals created opportunities for physical interaction, deliberations and negotiation as well as dialogues with different actors. Shared leadership has also served as a cornerstone in establishing a learning platform for MFAG. The study further points to the key role of governmental agencies in legitimising community-based flood risk management and in facilitating local disaster response and adaptation through policy interventions. However, the interactions with some governmental agencies were not fruitful as there were elements of distrust involved due to different priorities and agendas. This highlights the importance of different enabling factors interacting at the same time such as trust and participation.

Significance for practical solutions: Our empirical study highlights multiple enabling factors for stable, local learning processes, which can be instructive for future support to, and development of, local response strategies in the context of Disaster Risk Reduction in general, and flood risk management in particular. Recommendations are also put forward with regards to learning and collaborations across governance levels that appear useful for policymakers at the national and subnational levels.



ABSSUB-822

SC 9.12 Urban Africa: risk knowledge

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Research question: Africa's cities are the most rapidly expanding world-wide. This provides opportunities and challenges for adaptation. While accelerated urbanisation opens scope for new infrastructure and land-use planning to build risk management and adaptation into urban design this is constrained by the reality of urban capacity in Africa. In many cities more than half the population live in informal settlements. This not only constrains capacity and indicates vulnerability but makes strategic planning complicated. The range of organisations and values with an interest in urban resilience, and the asymmetry in power relations is large. This paper is concerned with the scope to which urban development can plan for risk reduction in African cities. It draws from the initial findings of a three year study Urban Africa: Risk Knowledge (Urban ARK) funded by DFID-ESRC. We work with 12 partners across six key and other associated cities.

Methodology: The paper brings together analysis of social vulnerability and urban governance from Ibadan, Nigeria; Niamey, Niger; Mombasa and Nairobi, Kenya; Dakar, Senegal and Karonga, Malawi. This allows comparison of the range of methods deployed to draw out their appropriateness. Appropriate application is assessed in terms of the capacity to capture and communicate vulnerability and adaptive capacity and action and also to feed into ongoing policy narratives and specific project discussions in each city. Specific methodologies are: Ibadan, a DesInventar style disaster loss assessment; Niamey, a Household Economy Assessment approach; Mombasa, Nairobi and Dakar, health impact analysis; Karonga community vulnerability and capacity assessment.

Findings: The paper brings together analysis of social vulnerability and urban governance from Ibadan, Nigeria; Niamey, Niger; Mombasa and Nairobi, Kenya; Dakar, Senegal and Karonga, Malawi. This allows comparison of the range of methods deployed to draw out their appropriateness. Appropriate application is assessed in terms of the capacity to capture and communicate vulnerability and adaptive capacity and action and also to feed into ongoing policy narratives and specific project discussions in each city. Specific methodologies are: Ibadan, a DesInventar style disaster loss assessment; Niamey, a Household Economy Assessment approach; Mombasa, Nairobi and Dakar, health impact analysis; Karonga community vulnerability and capacity assessment.

Significance for practical solutions: The comparison of methodologies enables comment on the significance of each for context specific risk management work. We accept that there are significant populations in African cities that lie outside the reach of public sector or formal market mechanisms. Yet these populations have adaptive capacities. Practical solutions are needed for risk management that can not only capture risk but enable reflection and organisation for risk management, even when this requires change in development pathway. The methods outlined open this discussion through their comparative analysis.



ABSSUB-1412

SC 9.13 BASE methodology framework for 22 case studies

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Research question: How to design, implement, monitor and evaluate 22 European case studies on climate change adaptation?

Methodology: The main goal was to examine 22 European sectoral and spatial multi-sector case studies of planned and autonomous adaptation to climate change, in order to draw bottom-up lessons on the planning, impacts, costs, benefits and implementation of adaptation measures in Europe. It included both non-participatory and participatory cases. Key sectors were examined in BASE according to the following Meta case studies groups: urban areas and coastal management; water management and ecosystem services; rural areas and food production. International case studies were also designed in order to be considered comparative case studies. It was designed a Case Study Living Document where all case studies had to report supporting case study design, data gathering and reporting.

Findings: All cases were implemented with success. We did a workshop with several stakeholder from the 22 case studies at ECCA conference and also requested to fill a questionnaire that allowed us to understand the effectiveness of each case study. We are also finalizing a questionnaire to each case study research coordinator as well as all researchers that had to use the case study living document to assess the benefits, challenges of a common research methodology and reporting framework when dealing with 22 European real and different case studies.

Significance for practical solutions:

- Sharing findings on innovative methodological designs that try to integrate and upscale data and information from local to European level;
- Support researchers but also local stakeholders to better design and document their own stakeholders to best support each other work;
- Provide a tested case study report framework that was inspired by the EU Climate Adapt platform, in order research case studies can contribute directly to this platform.



ABSSUB-1022

SC 9.13 BECCA – a multi-purpose guide and evaluation tool for Adaptation

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Research question: Which evaluation criteria are suitable for the evaluation of implementation of adaptation policies and measures? This paper presents the BASE Evaluation Criteria for Climate Adaptation (BECCA), an outcome of the EU-FP7 project BASE ('Bottom-up Climate Adaptation for a Sustainable Europe'). BECCA represents a comprehensive set of criteria from which the user should select those criteria that are relevant and salient in a concrete adaptation situation. As climate adaptation is highly context-specific, a standard evaluation would not be able to capture this specificity.

Methodology: BECCA is based on a review of existing frameworks and criteria sets for evaluating climate adaptation conducted at international and EU, Member States, sub-national and local level. We systematised these criteria, by grouping and showing interrelations between them. BECCA was 'road-tested' with the 22 BASE Adaptation Case Studies. On the basis of this feedback, we developed recommendations how and for which contexts the criteria can be used. With BECCA, we aim at contributing to attempts of upscaling and generalising the lessons learnt from context-bound adaptation initiatives.

Findings: We compiled a list of evaluation criteria for climate adaptation. The list contains 27 outcome criteria and 13 process criteria which can be useful for the evaluation of adaptation policies and measures. There are issues that pose challenges to meaningful evaluation of climate adaptation. The analysis of the case studies' feedback revealed that, even though the relevance of most criteria was unequivocal, difficulties became apparent in efforts to put things into practice. Feasibility to carry out an evaluation might be severely hampered by a lack of resources. Further, the assessment of many criteria are very challenging at the current level of awareness and technical expertise. On a positive note one may point out that there are also numerous BECCA criteria that can be applied reasonably at modest or low costs. This is particularly true for many of the process criteria, which can support decision-makers and stakeholders in identifying the right direction in developing adaptation measures. We therefore suggest that the evaluation of adaptation should generally start by examining relevant processes.

Significance for practical solutions: Evaluation of the implementation of adaptation policies and measures is more and more interesting due to the increasing implementation activities and policies. The BECCA with its framework and criteria set can support the evaluation of adaptation activities at local, regional and national level. Because of the road-testing with the BASE local case study the results are especially relevant for actors on local and regional level. Based on sound evaluation and monitoring activities good practice example can be elaborated and also used as showcases for other practitioners.

CROSS-CUTTING ISSUES
10. FINANCE, INVESTMENT AND
BUSINESS





ABSSUB-360

SC 10.1 Private finance for adaptation: what does it mean in practice?

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Research question: Private finance will play an important role in driving innovation and funding adaptation, particularly given the deficit between the funds needed to address adaptation globally and the limited availability of public sources. Many companies are taking a “wait and see” approach to climate action, while others are investing in managing risks to their businesses or offering goods and services that help adaptation. International finance institutions, such as Multilateral Development Banks and the Green Climate Fund, are trying to leverage private investment for adaptation with public resources. However, several challenges stand out: the long timeline of climate change which is ill suited to short term business planning; poor communication between the science community and the private sector; and the high costs of adaptation and uncertainty of financial benefits. Finally, a lack of capacity amongst project developers – particularly in developing countries – on how to pitch adaptation initiatives has hindered investment. The question we pose is how can the supply of good quality adaptation projects be improved in order to attract private investment and be brought to scale? A corollary question is what role can research play in bridging the gap between adaptation projects in developing countries and available funding?

Methodology: The research included a literature review on climate finance and adaptation in Africa, a series of interviews with key stakeholders done to advance the design of a funding programme on private finance for adaptation and two stakeholder consultations that took place through 2014-2015.

Findings: Key findings and information needs identified by this work included: (1) poor communication between adaptation specialists and the business community leading to a lack of uptake of adaptation in the private sector; (2) “adaptation” continues to be an abstract term and often unnecessary in the business environment; (3) The importance of taking a sectoral approach to adaptation (i.e. water, agriculture, transportation etc.); (4) the need to improve economics and finance research that can demonstrate tangible long and short term benefits of adaptation for society; (5) the need to improve the project supply of viable adaptation initiatives that speak to both profits and public goods; (6) the significance of identifying drivers that attract private capital. For example, the creation of markets for climate services and strengthening the link between climate finance agendas and domestic policy.

Significance for practical solutions: The results of this work has led to the establishment of new programming support for developing country researchers and practitioners to improve their capacity and readiness which was launched in April, 2015 by Canada’s International Development Research Centre. Longer term impacts will include improvements in the expenditure of both donor and private funds on helping societies adapt to climate change.



ABSSUB-377

SC 10.1 International adaptation finance: why the numbers don't add up and what to do about it

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Research question: In Copenhagen (COP 15, December 2009) developed countries pledged collectively to provide “new and additional” resources approaching US\$ 30 billion for the period 2010-12 – a short-term commitment called “Fast-Start Finance” (FSF) – to developing nations with balanced allocation between adaptation and mitigation, and to mobilize jointly US\$ 100 billion a year in climate finance by 2020. Which countries have been the highest recipients of international adaptation money so far? As simple as this question may seem, answers to it have proved to be highly controversial in the debates around climate finance.

To date most developed countries have heavily – but not exclusively – relied on the data that they collect using the OECD Development Assistance Committee (DAC) Rio marker methodology to report to the UNFCCC Secretariat on their financial commitments. In the absence of any internationally agreed definition of what counts as adaptation finance and how to count it, these data are often used as a proxy for international adaptation finance. They therefore play a relatively important role in our understanding of the current climate finance landscape.

Our contribution investigates the case of Vietnam as this country emerges as the first recipient of adaptation aid according to the Rio marker methodology. Available data from the DAC show that Vietnam has attracted almost 12% of adaptation-related bilateral ODA during 2010-2013 – in comparison less than 3% of bilateral ODA was devoted to this country during the same period of time. But how reliable is this observation? As our contribution will demonstrate, definitional and methodological biases paint a more complex picture.

Methodology: This study is based on interviews done during a field research stay in Vietnam, complemented with analysis of relevant data and reports.

Findings: In the first part of our contribution, we provide a systematic analysis of each adaptation aid activity carried out in Vietnam during the period 2010-2013. Such an analysis puts in perspective the observation that Vietnam was the first recipient of adaptation aid so far. It also illustrates some of the practical challenges of monitoring international climate finance and some of the weaknesses of current reporting systems in this regard. We discuss them in the second part of our contribution, along with current efforts by the DAC to improve the tracking of climate finance.

Significance for practical solutions: Our contribution highlights some of the limits of a strictly accounting approach to international climate finance aiming at counting adaptation aid separately from other interventions – an approach that is however particularly apparent in UNFCCC negotiations. This approach could indeed provide a disincentive to use some types of aid (such as general budget support or debt relief) that are potentially highly relevant to address intersectoral issues such as climate change adaptation. Some possible avenues for improvement are therefore suggested in the last part of our contribution.



ABSSUB-1085

SC 10.1 Financing tools for urban adaptation to climate change impacts

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Research question: Adaptation can be costly, especially in the case of infrastructures. Cities are among key actors of adaptation, but the access of finance is critical. The research questions are : what are the possible financing tools for urban adaptation ? what are the barriers and levers to use them?

Methodology: Based on a literature review and dozen case studies, driven both from grey and green infrastructures.

Findings:

- in developed countries, we show that several tools are possible (PPP, local taxes, crowdfunding, insurance, etc.) but rarely used because of their complexity and the difficulty to distinguish the adaptation aspect from more general measures. The involvement of the private sector is often a key issue.
- in developing countries, we analyse 27 funding initiatives that cities can use to implement adaptation projects, offering additional options to more conventional sources of funding for climate change and sustainable development (national budget transfers, Official Development Aid, etc.). We show a strong prevalence of initiatives supporting soft adaptation measures (strategy planning, capacity building, project design, technical assistance, etc.). The mapping also reveals that local intermediaries (regional and local banks, national development funds, etc.) play a significant role in financing urban adaptation to climate change. Several key factor of success for the cities' access to these sources of funding are also identified, among which liaising with international development stakeholders (such as multilateral and bilateral donors) at the local level, and the identification of various co-benefits and synergies between the economic, environmental and climate impacts.

Significance for practical solutions:

- help cities to have access to financing tools
- identification of key conditions for success

ABSSUB-558

SC 10.1 Private sector investments in a changing climate: resilient rice value chain development in Uganda

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Research question: The Government of Uganda has identified rice as a priority crop for improving food security and household income. This study investigates how private sector investments support climate risk management (CRM) along rice value chains in Uganda, with a specific focus on domestic seed companies and commercial banks. The aim is to identify investment options that increase the climate resilience of multiple value chain actors, while also benefitting the private sector entities in terms of profitability and risk



management. This will lead to policy recommendations for the Government of Uganda to support the participation of businesses in CRM.

Methodology: Using a case study approach, the research is conducted in collaboration with two private sector actors: Equator Seeds, a domestic seed company investing in new rice seeds in Northern Uganda; and Centenary Bank, a leading commercial bank, focusing on their microfinance services for rice value chain actors in Eastern Uganda. Qualitative data on climate risks, current responses and the impacts of the private sector investment were collected through focus group discussions and semi-structured interviews with key actors along the selected value chains, including input providers, farmers, traders and consumers. Based on this, proposed investment options were identified through dialogue processes with relevant experts and policymakers. A multi-criteria analysis approach was used to evaluate these options in relation to the CRM priorities of different actors.

Findings: While data analysis is ongoing, preliminary results indicate that climate hazards are negatively affecting all actors along the rice value chains. Investments by Equator Seeds and by the Centenary Bank already support CRM along the value chains, however further improvement is possible, especially at the production level. For rice seeds, options for improvement focus on supporting decision-making by farmers and ensuring adequate, consistent and timely supply of new seeds. For financial services, there are opportunities to introduce new services and to adjust the terms of existing products. In both cases, collaboration with other actors is a key enabling factor.

Significance for practical solutions: To date, most discussions on the role of the private sector in addressing climate change have focused on ways for large multinational companies to better manage risks and decrease greenhouse gas emissions along their global supply chains. This study fills a gap by focusing on the role of domestic businesses, particularly small and medium enterprises (SMEs), in supporting CRM along local and regional agricultural value chains. This is important considering the domestic private sector remains the largest investor in agriculture and that SMEs create the majority of jobs in many developing countries. Recognizing the need for a systematic approach to CRM, the study presents a practical framework for climate-resilient agricultural value chains, and provides examples of business opportunities for supporting CRM.

ABSSUB-1363

SC 10.1 Mobilising private adaptation finance: developed countries' perspectives and experiences

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Research question: How do developed countries define and motivate private sector adaptation finance? At the UN climate negotiations, developed countries pledged to mobilise USD 100 billion of climate finance annually from 2020 onwards to support developing countries to address climate change. Developed countries persisted on the private sector being one of the sources of finance. Yet it remains unclear what private climate finance actually is, and how to mobilize and account for it. This is particularly the case for adaptation.

Methodology: This paper analysed three sets of policy documents as submitted by developed countries the UNFCCC. The paper analysed how developed countries define and motivate private sector adaptation finance; their current experiences; the actors and instruments they involve; and tracking of private finance.



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Through interviews with experts from development banks and -agencies, practical experience on adaptation projects with the private sector was added for comparison.

Findings: This paper shows that there is a discrepancy between the perspectives of global negotiations and local implementation. On a global level, developed countries' objective to mobilize private sector finance is abstract, and private sector awareness is low. At the level of implementation, development institutions aim for private co-investments in increased resilience rather than for adaptation. Here, private sector awareness and experience can be found. Furthermore, although developing countries often voice their scepticism on private climate finance at the climate negotiations, in practice they often favour private sector participation in adaptation implementation, as it creates jobs, tax revenues and economic growth.

Significance for practical solutions: The abovementioned discrepancy questions the usefulness of the inclusion of private adaptation finance under the global political goals to mobilize USD 100 billion of climate finance per annum. This mobilisation is in fact impeded by disputes on how to account private finance, where instead it should focus on mobilising finance that effectively addresses adaptation needs. The author thus recommends to focus on outputs on the ground and to mobilize private investments on the way. This enables ground trothing and will paves the way for more robust accounting in the medium-term future.

ABSSUB-355

SC 10.2 Evaluating climate change adaptation for the Maldives' tourism industry

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Research question: In this project, we explored the question, What are the economic costs and benefits of climate change adaptation to the private and public sectors for the Maldives' tourism industry?

Methodology: We designed our research to systematically screen and evaluate climate change adaptation options for the tourism industry in the Maldives using two approaches. First, using a stakeholder-driven multi-criteria analysis (MCA), we evaluated the social, environmental, technical, and economic trade-offs of eight coastal protection adaptation options that aim to minimise loss and damage to coastal infrastructure, resources, and livelihoods from sea level rise and storm surge events. Second, using a benefit cost analysis (BCA), we quantified the costs and benefits of raising the height of an existing seawall to mitigate damage from future storm surge events.

Findings: The results of the MCA revealed stakeholders' preference for "soft" coastal protection adaptation options (e.g. coral reef protection, coastal vegetation buffers, and beach nourishment). These more-preferred adaptation options are lower-cost, higher-benefit options that are robust to a wide-range of climate futures and are flexible in adapting to evolving conditions. In the BCA, the value of raising the height of a seawall depended on whether damages from storm surge events occurred during the low- or high-tourism seasons: the return on investment was positive during high-tourism season, regardless of storm surge frequencies, discount rates, and the project lifetime; the return on investment was only positive during the low-tourism season when the storm surge occurred every year. The findings also suggested that hard adaptation options, such as seawalls, can provide the tourism industry with time to decide how to adapt to future climate



changes; with time may come improved projections of climate change impacts and new adaptation technologies that may help the Maldives address future challenges.

Significance for practical solutions: The Maldives' tourism industry is extremely vulnerable to the effects of climate change because of its geography and the dependence of its economy on natural resources. Without changes to current global resource use, the Maldives is projected to experience potentially significant economic losses in the tourism sector. Climate change adaptation may be critical for reducing these economic losses. Evaluating the advantages and disadvantages of adaptations from a public- and private-sector perspective is important in selecting the most appropriate suite of adaptation options for the tourism sector. This study provides a qualitative and quantitative framework for evaluating stakeholder preferences for a suite of climate change adaptation options.

ABSSUB-825

SC 10.2 SMEs and climate risk –perception, experiences and responses

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Research question: Small and Medium-sized Enterprises (SMEs) form a key part of our economy but very little is known about their ability to respond to climate risks such as flooding. In this paper we analyse a recent survey of 1,199 small businesses across the UK, conducted by the Federation Of Small Businesses. The survey provides new insights on SME behaviour in the face of extreme weather events and climate change, with a particular focus on perception, exposure and responses to risks by SMEs.

Methodology: Our analysis of the survey data explores the perceived impacts on different business functions; the motivation to undertake adaptation action; the barriers to SME adaptation; and implications for the role for SMEs in community adaptation.

We compare this to earlier findings, the general literature and consider this in the context of the current discussions about climate adaptation in the UK and beyond.

Findings: The survey highlights several aspects worth further investigation:

- 66% of SMEs surveyed SMEs have been impacted by a weather event. Out of the above response, 46% of the effect was on staff and customers and 32% on logistics. Our study will compare this to earlier findings and investigate this further across sectors and geographic areas.
- Out of the surveyed SMEs 27% had a business continuity plan, but only 11% included weather in as a risk. We investigate why only 11% of those firms included weather in their BCP.
- Motivation to undertake adaptation or resilience measures is a key area that lacks understanding. The survey offers some insights (8% responded a financial incentive, whereas 35% responded 'none of the above') which we will investigate further.
- The survey revealed that 40% of SMEs would be willing to act as 'community hubs' in case of future flooding. This is a relatively new area that deserves further investigation. We are particularly interested in the implications for businesses and communities as well as the nature and characteristics of these hubs.
- Another key area is 'barriers' to adaptation/resilience. 17% of the SMEs mentioned that they need to adapt to face extreme weather, but reported that they had no time due to their current workload and



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demands. A further 18% mentioned that they do not anticipate climate change to be an issue. This is a very interesting response for policy makers and practitioners who are keen to see behavioural change and who consider how to assist SMEs in this area.

Significance for practical solutions: The FSB survey has been conducted at a very crucial time. Policy makers at global, national as well as local level are considering the role of SME's in response to a changing climate. The survey provides new insights on SME behavior in the face of extreme weather events and climate change. Comparing those new findings to the existing literature as well as conducting further cross tabulations with the raw data would allow us to address a current knowledge gap and to contribute to the policy discourse.

ABSSUB-814

SC 10.2 Cost-benefit analysis of adaptation options for communities, regions, and economic sectors of Canada

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Research question: How can cost-benefit analysis (CBA) be applied to assess alternative adaptation options and thereby support adaptation decision-makers in communities, regions, and economic sectors impacted by a changing climate?

Methodology: This presentation will discuss case studies involving the application of CBA of adaptation options, undertaken in collaboration with stakeholders and decision-makers in communities and economic sectors impacted by a changing climate in different regions of Canada. CBA case studies were conducted in coastal communities/regions and in the Great Lakes-St. Lawrence river region, following common methodological guidelines but with specific methodologies adapted for each case. Some case studies focussed on the economic benefits/costs of adaptation measures to protect property and transportation infrastructure while other cases incorporate not only economic impacts, but also environmental and social costs. Stakeholders and decision-makers were engaged in order to address data gaps, identify adaptation options and validate results. Other CBA case studies on adaptation options in mining and forestry sectors will also be discussed.

Findings: Emerging results show that the availability of adaptation options with net benefit, and the magnitude of net benefit, vary greatly across case studies. Early results suggest that largest net benefits from adaptation may be realized when climate change poses a risk to the broader regional economy or to key ecological services or environmental amenities. Other factors underlying the potential benefit from adaptation include the risk exposure of valuable property and infrastructure, and the availability of low-cost adaptation measures. A key lesson from conducting the CBA case studies is the importance of mechanisms to allow stakeholders to provide input and guidance to address data gaps, and to enhance the relevance of the analysis.

Significance for practical solutions: In some of the cases studied, practical adaptation solutions have been identified with significant net benefits. In other cases, where the costs outweigh the benefits of adaptation for a local community or for a single private company, the redesign of adaptation strategies at a broader regional scale and the development of partnerships to share costs among multiple public and private entities



may be practical avenues to reach adaptation solutions with greater net social benefit. A key challenge is to address the distribution of costs and benefits, which may act as a barrier to implementation of adaptation measures, even when net social benefits may be realized. In addition, innovative mechanisms to finance adaptation investments are needed.

ABSSUB-694

SC 10.2 The impacts of climate change on food value chains

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Research question: A value chain is defined as the path by which a product is created and marketed. The effective functioning of chains is critical in achieving core economic objectives such as consumer confidence, economic stability and food security. Food value chains, like many others, are pre-disposed to climate risk, with impacts experienced across all components of the chain. Despite this knowledge, there remains minimal guidance for companies in identifying or implementing mitigation/adaptation options across their value chains. The study that we present here was established to help companies identify the direct and indirect impacts of climate change on their value chains, and formalise an approach to identify, assess, prioritise and act upon risks and opportunities that a changing climate might present upon their chains.

Methodology: We employ value chain analysis methods to investigate the value chains of three Australian food and beverage companies.

Findings: In all three case studies, climate change impacts can be felt in multiple stages of the chain, reinforcing the need to widen the scope of adaptation research to the system that supports agriculture and farming – the value chain. The implementation of adaptation options, identified at specific nodes of the chain, can have significant impacts on functions of other nodes of the chain, and can result in unintended consequences if not considered in the context of the whole. The impacts of climate change on product quality in the case study chains seem to be minimised via processing and strict quality standards. To some extent, processing and quality assurance have become a form of adaptation to fluctuations in climate. However, as the scale of climate change increases, end quality of the product is likely to decline; consumers are likely to eventually feel the impact of climate change on the quality of the food that they consume. However, consumers at present are not aware of this, and as such do not currently value attempts to adapt existing value chains. Our study highlights that food value chains are currently experiencing the impacts of climate change, and for the most part, are adapting to climate change through incremental responses.

Significance for practical solutions: The challenge for chains therefore, is to strike a balance between the cost of maintaining quality standards and reputation, against the cost of adaptation. A balance also needs to be struck on who bears such costs, and how this can be managed across the chain in a manner that enables sustainability and profitability. Successful adaptation to climate change will likely involve a broadening of risk and resilience perspectives to a more proactive, opportunity-based stance. The complexities of climate change impacts on value chains, and the resulting need for systems adaptation suggests opportunities for support by providing strategies to evaluate risk and strategically plan for whole-of-chain adaptation.



ABSSUB-949

SC 10.2 Surface water flood risk and management strategies under future climate change: An ABM approach

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Research question: In this paper we present a novel methodology for assessing different structural adaptation options for surface water risk in the context of climate change. We apply this to a London-based case study to analyse how risk reduction could be achieved by homeowners and government and the role flood insurance can play. Particular interest in the interactions between flood insurance and flood risk management stems from current changes to the UK flood insurance system. A new flood insurance pool, Flood Re, is expected to become operational in 2016- designed by Government and industry as to provide affordable insurance for the highest risk properties whilst helping to smooth the transition to more risk-based pricing in the future. However, concerns have arisen over the financial sustainability of the scheme given that costs will be higher than benefits delivered; as surface water flooding has not been adequately reflected in the risk modelling; and as the new system is not designed with risk reduction in mind and offers no incentives to encourage household level flood risk reduction. Implications of the scheme, and potential negative and positive feedbacks, have also not been considered in parallel with other flood risk management options.

Methodology: These issues are investigated through an Agent-Based Model (ABM) developed for Greater London and applied to a detailed case study of one of London's Boroughs. Using probabilistic surface water flood event time-series and GIS data the ABM allows the investigation of different flood risk management options and combinations of options. The method is novel in both its coverage of different combinations of flood risk management options, insurance, and Flood Re, and its ability to model changing behaviour, decision making, flood events, and flood risk in a dynamic manner.

Findings: The model illustrates how different adaptation options could contribute to reducing London's surface water flood risk, today and in the future, and along with insurance options potential benefits for homeowners and the wider housing market. By focusing on different agents (including homeowners, the government, insurers, and developers) the role of incentives to promote risk reduction are investigated. The model highlights how Flood Re acts to lower flood insurance premiums, reducing the number of house foreclosures and positively influencing the local housing market. However, flood risk also increases in scenarios with the Flood Re scheme in place.

Significance for practical solutions: The results highlight the need for better understanding of the implications of Flood Re and how such a partnership between government and insurers could be better developed to help promote effective flood risk reduction measures, particularly given the additional impacts seen under future climate change scenarios.



ABSSUB-1304

SC 10.2 Business exposure and risk awareness of telecoupled climate effects: examples from Swedish industry

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Research question: Mitigation of climate change is generally seen as a global endeavour. The impacts of climate change and – consequently – adaptation tend on the other hand to be viewed as a local problem. This view we argue is seriously outdated, not reflecting current realities. Flows of capital, goods and people are creating a world where not only the geophysical aspects of climate are global, but the socio-economical aspects as well. This is especially relevant for businesses that operate through their global supply chains and interactions on global markets. These so-called telecoupled (also called indirect impacts of climate change) effects were clearly seen in the aftermath of the 2011 floods in Thailand, which adversely affected global supply systems for computer hard drives. Despite these experiences, research into the exposure of global business to global climate change has so far been rather superficial. In this study we ask, for the case of the Swedish export industry, what are telecoupled effects of climate change for businesses, how much aware are businesses about telecoupled effects of climate change and what actions or strategies have business taken that address telecoupled effects of climate change.

Methodology: The findings presented are based on two separate, but interlinked studies. The first study uses a newly developed indicator-based framework to quantitatively assess the exposure of businesses to telecoupled impacts of climate change. As an example case, the exposure of the Swedish forest industry is analysed. The second study is a qualitative study using interviews with Swedish businesses to assess the level of organisational risk awareness and if and to what degrees businesses have taken measures to adapt to these risks.

Findings: Preliminary results from the first study suggest that key exposure of the Swedish forest industry lie not in its supply chains – which tend to be restricted locally – but rather in export markets with heavy exposure to regions where climate change is expected to have serious negative effects with potential spillovers into livelihoods, purchasing power and overall market stability. As for the second study, awareness of the risks of distant climate change effects seems to be rather low. Established supply chain management and risk management strategies do not anticipate emerging risks from climate change.

Significance for practical solutions: The results presented herein have clear relevance not only to business actors who want to increase their knowledge about the impacts of climate change in a continuously more complex and interconnected global economy, but also to public adaptation planners as well. In many cases the key risks of climate change might not be the effects seen locally but possibly at the far end of a supply chain.



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ABSSUB-1271

SC 10.3 A (physical) science perspective of the risk of L&D: implications for decision making

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Research question: In this talk we review the role of climate science on the implications of Loss and Damage (L&D) for decision-making.

Methodology: The characterisation of the risk underlying L&D involves an understanding of the socio-economic risk drivers including exposure and vulnerability and of the physical risk drivers such as the climatic hazards.

This paper reviews the different sources of information used to evaluate the current and changing likelihood of climatic hazards, emphasizing the role of uncertainties in different decision making contexts.

Findings: When considering the total risk, the climate dimension just adds to the uncertainty derived from the wide range of socio-economic and environmental factors considered. Different strategies to deal with this uncertain information can be used depending on the policy goal underlying L&D.

A first objective could be to create awareness about the sensitivity of human and natural systems to climate, and the need to respond with appropriate mitigation, adaptation and disaster risk reduction policies. For this purpose, science can provide robust information on trends and plausible changes in current hazards including estimates of the level of confidence in the forecasts.

A second goal could be to design risk reduction and risk management strategies aimed at enhancing adaptation in order to reduce vulnerability and build resilience. In this case the most appropriate tool is a comprehensive risk management approach that starts by defining the policy or adaptation goal, for instance to reduce the risk of L&D resulting from particular extreme event to tolerable levels, and plan the management of the residual risk that cannot be minimised. Finally, a third aim for characterising changes in climatic hazards could be to inform compensation arrangements for L&D. For this to be possible the incremental fraction of loss and damage that can be attributable to anthropogenic climate change would need to be computable. In many cases of interest, limitations of current climate modelling tools hinder a robust estimation of this likelihood. In addition, attribution of the underlying weather event does not imply anthropogenic climate change attribution of the total risk.

Significance for practical solutions: This paper forms part of a new initiative to bring together experts of L&D in order to support policy makers in their efforts to design and implement the UNFCCC's Warsaw Loss and Damage Mechanism (WIM), and it will be part of a special session on L&D organised by IASA and others. As a contribution to inform the current debate underlying WIM, this paper aims to explore the role that climate science can and cannot play depending on the policy objectives of L&D.



ABSSUB-1307

SC 10.3 Trends and projections of weather impacts: attribution relevant to the Loss & Damage Mechanism

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Research question: Under the UN Framework Convention on Climate Change, the Loss & Damage mechanism is aimed at dealing with climate-related effects, including residual impacts after adaptation. The role of anthropogenic climate change in past and future losses has been researched in a variety of studies. The knowledge coming from these studies was recently summarised in IPCC reports such as the SREX and WG2 contribution to the Fifth Assessment Report. The key question is to what extent anthropogenic climate change has already led to increases in losses and damages, and what can be expected for the (near) future.

Methodology: In this presentation the analysis of past extreme events and disaster impacts and their costs as presented in these IPCC reports and new studies since, will be presented. An interpretation is provided of why losses have changed (mostly increased), and how these losses are projected to increase further in the future. These studies are based on empirical loss records, as well as risk quantification coming from risk analysis approaches and catastrophe models.

Findings: Historically, as well as for projections of near future risks, socioeconomic development has been and will remain the main driver for increases in losses. There are some indications however, that vulnerability in some areas and for some risks has decreased over recent decades, and this will add to the complicated development of future losses.

Significance for practical solutions: The understanding of the variability in losses, these difficulties in attribution to anthropogenic climate change, as well as possibilities to quantify and manage risks will be discussed, with relevance for the current developments under the Loss & Damage Mechanism, including options for financing and risk transfer.

ABSSUB-1415

SC 10.3 Perceptions of loss and damage from a range of stakeholders: implications for science and policy

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Research question: The Warsaw International Mechanism for loss and damage (WIM) was established in 2013, and is due to be reviewed by the UNFCCC in 2016. Yet there are many aspects of loss and damage which still remain unclear, and many different interpretations of what "loss and damage" signifies. Whilst



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there may be good reasons for this ambiguity, it can also inhibit productive dialogue about practical actions and research priorities to address loss and damage. The presentation will report on a project which seeks to bring clarity to the debate, by investigating perceptions of loss and damage from a range of stakeholders.

Methodology: The research is based on interviews with 40 key informants including scientists, practitioners, and negotiators; with expertise in UNFCCC processes, adaptation, disaster risk reduction, and the emerging field of loss and damage. The interview data have been triangulated with peer-reviewed and grey literature to develop a set of typologies of loss and damage.

Findings: The typologies demonstrate several issues over which stakeholder perceptions diverge, including the distinction between adaptation and loss and damage mechanisms, the importance of addressing climate change impacts versus any climate-related disasters, and the relevance of questions about justice. The analysis has also delivered interesting findings about the context which makes defining loss and damage so challenging. The presentation will reflect on the role of science in the emergence of loss and damage and the lack of specificity over the nature of adaptation: the loss and damage agenda is also raising questions about how to define adaptation.

Significance for practical solutions: The research has been designed to support the WIM, with encouragement from the UNFCCC secretariat. The typologies will be used to facilitate discussion about policy actions and research needs to address loss and damage. The presentation is designed to generate such discussion at the Adaptation Futures conference, and this will complement a workshop, planned for early 2016, to bring together scientists, practitioners, and policy-makers to discuss potential actions which would be consistent with the various definitions, and deliver a set of potential policy options which will be presented to the Executive Committee of the WIM in time for the review at the 22nd Conference of the Parties in Morocco in 2016. As well as informing international policy, the discussions have the potential to generate innovative solutions which can be taken up directly by newly formed partnerships between scientists and practitioners.

ABSSUB-1425

SC 10.3 A climate risk management approach for the Warsaw Loss & Damage Mechanism

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Research question: How to achieve fair process and equity in outcome for the Warsaw Loss and Damage Mechanism (WIM), which holds high appeal for transforming both adaptation and mitigation as well as delivering needed finance for climate risk management?

Methodology: The methodology comprises of argumentation building on the ethics of climate change as well as risk analysis involving climate risk modelling linked to country stress testing.

We deliberate principles of distributional and compensatory justice for identifying an equitable process and outcome for the WIM. We also conduct stochastic risks analysis linked to country stress testing to identify risk and costs of large-scale events that are beyond adaptation

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Findings: Negotiations on the WIM under the UNFCCC are caught in between the red lines of a demand for climate justice (compensation for increases in extreme event risk) raised by non-Annex I countries, and the unwillingness of non-Annex I to consider Loss & Damage outside of an adaptation framework. We are suggesting an actionable way forward for the deliberations based on the concept of climate risk management and principles of distributional and compensatory justice. The approach involves in a short-medium, needs-based perspective, support for risk management beyond countries' ability to absorb risk; in a medium-longer term rights-based perspective, it upholds a consideration for liabilities attributable to climate change. For the short-medium perspective, we calculate country needs in terms of external support for absorbing high-level climate-related disaster risk. The suggestions are based on country-level stress-test modelling and good practice examples of disaster risk management using the CATSIM model. The calculated cost for absorbing high-level climate-related risk are in the lower billion USD, but if efforts are well linked to risk reduction incentives, such an approach may lead to strongly reducing the adaptation deficit and large cost savings to the international community in terms of reduced ex-post spending on disasters.

Significance for practical solutions: The WIM has risen to the fore in policy debates and some consider it the "3rd pillar of the work under the UNFCCC in addition to mitigation and adaptation." There is high relevance for practice and policy in terms of identifying an actionable and fundable mechanism for supporting countries in their efforts for dealing with climate-related impacts. Yet, the terrain remains extremely contested with 'Southern countries' at risk (such as AOSIS) demanding climate justice, while Northern negotiators are unwilling to even consider such framing and related action; yet, they may be willing support adaptation and have supported 'good' risk management over the years, as evidenced by debates based on moral responsibility that informed the approval of the Sendai Framework of Action.



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Potential of urban vegetation for reducing heat-related hospital admission in western Sydney

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Research question: What is the potential of various urban vegetation schemes in reducing heat-related hospital admissions across Western Sydney area?

Methodology: Historical hospital admission and weather data were used to quantify the potential benefit of urban vegetation in reducing heat-related hospital admission rates in Western Sydney. This involved the use of a meso-scale urban climate model to simulate the average summer daily mean (ASDM) temperature using ten different urban vegetation schemes. The vegetation schemes ranged from little vegetation represented by the current Parramatta CBD through to leafy urban suburbs, to full revegetation schemes represented by grassland, bush land and sparse forest. Correlations were established for two age groups 0-64 and 65 years plus between mean daily air temperature and hospital admission rates for dehydration (DEHY) and heat exposure (HEAT) from 1991 to 2009. The correlations were then applied to the weather data generated based on the ASDM temperature using the urban climate model for each of the ten vegetation schemes.

Findings: Except that the daily DEHY admission rates for the 0-64 year group is weak, the daily DEHY admission rates for the 65 years plus group was well correlated with mean daily air temperature. It was also found that the daily HEAT hospital admission rates are strongly correlated with the mean daily air temperature for both age groups – 0 to 64 years and 65 years plus. The results show that hospital admission rates are expected to reduce with increased urban vegetation. When compared to the existing urban vegetation scheme, a leafy urban suburb was estimated to reduce the projected daily hospital admission rates for DEHY and HEAT by 15% and 30%, respectively.

Significance for practical solutions: The results highlight the importance of promoting urban vegetation as a strategy for adapting our urban environments to the potential health consequences of extreme heat.

ABSSUB-453

A multi-hazard city level impact assessment for the concepción metropolitan area, Chile

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Research question: Several studies have explored specific impacts of droughts, floods, heat waves, increased ocean level, etc., and there are a growing number of studies which explored these impacts exclusively on urban areas. However, only a few explore multi-hazard impacts. This study describes the first multi-hazard impact assessment of exposure and sensitivity to climate change in Chile. We explore the impacts of climate change in the nine municipalities of the Concepción Metropolitan Area (CMA). This research seeks to answer the following questions:



1. What was the level of exposure and sensitivity of CMA in 1992 and 2002?
2. How did the level of exposure and sensitivity changed between municipalities in CMA from 1992 to 2002?
3. Which hazards are the most influential in the level of exposure and sensitivity of the CMA' municipalities?

Methodology: A flexible methodology based on spatial fuzzy logic modelling was developed that can be applied in a wide range of contexts. A set of indicators derived from census-based data available for all the municipalities in Chile were standardised and then aggregated through a stepwise approach into a multi-hazard impact index. Five natural hazards were analysed: coastal flooding, river flooding, water scarcity, heat stress, forest fires and vector-borne diseases. The level of exposure, sensitivity, as well as a multi-hazard impact index were mapped for all municipalities. As the same indicators were recorded for 1992 and 2002, they can be compared to reveal changes over a 10 year period.

Findings: Over the studied decade, all the municipalities increased their level of exposure and sensitivity. However, the level of exposure increased more than that of sensitivity. The relative levels of exposure between municipalities did not change significantly. This implies that the important differences observed between the municipalities were maintained over the studied period. Meanwhile, the level of sensitivity increased slightly. The poorest municipalities are the most sensitive and often more exposed to multiple hazards. These results suggest that efforts to start the process of adaptation of the municipalities should focus not only on reducing the current exposure and sensitivity but also in reducing the wide disparities observed between municipalities.

Significance for practical solutions: This approach was designed to be readily applied to all urban municipalities in Chile, and potentially other countries. Our findings can help stakeholders and policymakers in municipalities, contributing to their understanding of the preconditions for planned adaptation, i.e. "situational analysis", the first step in the planning process for climate change in cities. Identification of these exposure and sensitivity can stimulate dialogue amongst policymakers and stakeholders regarding how to manage urban areas and how to prioritise resources for urban development in ways that can also improve adaptive capacity and thus reduce vulnerability to climate change.

ABSSUB-444

Climate change adaptation in European cities – insights from responses to the CDP's cities programme

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Research question: Globally, climate change related risks and impacts are increasing steadily while urban areas are hit in particular. However, cities, home to more than half of the world's population and important economic hubs, are not only particularly vulnerable but also worthy to protect. To address challenges caused by climate change, implementing adaptation measures to increase resilience and minimise damage is inevitable. This paper provides insights into climate change and adaptation related risks and opportunities that cities identified and determines differences according to the cities' sizes.

Methodology: The CDP provides a voluntary climate change reporting platform for city governments to disclose information on GHG emissions, climate change risks and adaptation strategies. In this paper, responses by 40 European cities to the 2014 CDP Cities Information Request on the topics of "Risks &



Adaptation" and "Opportunities" serve as analytical basis. The responses have been sorted and evaluated to provide an overview of the most important outcomes.

Findings: The analysis shows that 92.5% of the responding European cities report that they face physical risks arising from climate change and that they identify more intense rainfall (62.5%) as the most relevant physical risk. Furthermore, more than half of the participating cities (55%) indicate that they are facing social risks due to climate change with increased risk to already vulnerable populations (35%) being the most important one. However, 72.5% of the cities report that they see economic opportunities arising from climate change and more than half of the reporting cities (57.5%) identify development of new business industries as the main economic opportunity. Furthermore, 55% of the observed European cities indicate that they have already implemented adaptation action plans and 82.5% of all cities are putting adaptation action into practice with the majority of these adaptation actions dealing with more intense rainfall (50%).

Significance for practical solutions: City governments already show awareness, interest and knowledge in addressing climate change issues, but at the same time there is a still huge demand for information and guidance due to the complexity of urban planning, among other factors. Whereas the method used by CDP has some shortcomings, it is an important tool to gain insights into the way city governments deal with climate change issues and to identify gaps in climate-related information and knowledge. Moreover, the CDP Cities Information Request confronts cities with the topic of climate change and might trigger adaptation actions. The variety of answers shows that there is no "one-size-fits-all" solution for adaptation, thus, the study's findings can also serve as an innovative starting point for further research.

ABSSUB-1443

Making room for water? Contested visions of urban adaptation and development in Jakarta

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Research question: In January 2013, massive floods in Jakarta again called attention to the city's failing infrastructure and the plight of residents, particularly in the informal "kampung" settlements along the city's thirteen rivers. Jakarta's flooding precipitated a surge of interest from the city government and scientists, designers, and planners around the world, while local activists rued the focus on large-scale redevelopment, and organised against evictions and displacement. The most eye-opening response came a year later. On a visit to Jakarta, Netherlands Minister Melanie Schultz announced the masterplan for a massive sea wall project, developed by Dutch consulting firms. Resembling a giant Garuda, Indonesia's national symbol, it is a new city for 1.5 million people built right in the Jakarta Bay. The "Giant Sea Wall" promises to solve flooding problems, ease congestion, and provide a new financial centre. Urban climate change adaptation has often been characterised by the challenges facing specific localities – particularly the lack of resources and effective governance. How are conditions like that in Jakarta, and projects such as the "Giant Sea Wall," shifting the constraints and sites of urban adaptation? My presentation explores the contested visions of change, the interconnectedness of local and global relationships, and the role of design in adaptation projects.

Methodology: I conduct a mixed methods study of the Jakarta Giant Sea Wall masterplan, combining semi-structured interviews with field and participant observation, and spatial and visual methods. Because



the Jakarta case is intricately tied to institutions and initiatives in the Netherlands, I also build on frameworks for a more reflexive approach to case selection and analysis and a relational reading of sites – each understood through the others. More broadly, this case is part of a larger study to develop methods of urban relational analysis to study disparate yet highly interconnected sites.

Findings: I find that adaptation projects in the context of climate change are increasingly intertwined with multiple scales of globalized urban and economic development. In this case, the objectives of the Indonesian national government, the Netherlands government, and Dutch water and infrastructure firms intersect in specific, and mutually beneficial ways. At the same time, the issue of social justice and equity remain largely unaccounted for. This new context presents new sites of struggle for community activists, who have formed innovative coalitions to propose alternative visions for adaptation.

Significance for practical solutions: Adaptation planners invested in social and environmental justice should look systemically at the process and institutions of large-scale projects, not simply within the city, but far beyond it. They as well should develop methods to recognize and work with grassroots social practices, to understand the ways in which such alternative visions can be harnessed in envisioning the future of cities in the context of climate change.

ABSSUB-1122

The effects of training & distance on resilience: biogas interventions in informal urban settlements

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Research question: This paper identifies training as a key factor to build resilience when implementing Biogas, Water Hygiene and Sanitation (BWASH) development interventions, using a case study involving an Informal Urban Settlement (IUS) in the city of Shashemene, Ethiopia. It further identifies distance from the BWASH facilities as an additional key factor that enhances resilience at community-level, thus addressing key vulnerabilities to climate variability, and change. Community investments in small-scale biogas digesters, inclusive of WASH components, can have multiple advantages for low-income households in IUS, including improved health standards, increased energy supply, lower expenditures for biomasses through making use of the bio-methane, and the availability of bio-fertilizer to enhance crop productions. In general BWASH interventions are believed to promote multi-dimensional development at community level. However, knowledge gaps still remain as to whether, and to what extent, training provided within BWASH interventions can build resilience to climate variability, and change. Additionally, there is little information on the optimal distance that households should have from such BWASH facilities to fully exploit the benefits arising from the intervention.

Methodology: The proposed framework employs a mixed methodology to be applied at community-level, including both qualitative participatory methods (using the adaptation tool CRISTAL) and a quantitative (quasi-experimental) assessment of the effect of intervention using matching techniques. The research involves two waves of original data collection, both of which involved household surveys (N=400).

Findings: The study finds that training had positive effects on a number of key indicators, believed to be key in building resilience at community-level. These include the use of improved sanitation facilities and management of wastewater and sewage. Additionally, households who live closer to the facilities and also



received training enjoyed further benefits, such as reduction in typhoid, increased self-assessed health, and improved food security, reinforcing arguments for the inclusions of both training and distance as key factors to estimate the overall benefits of such BWAASH interventions.

Significance for practical solutions: With many BWAASH programmes being implemented at national level in urban areas of LDCs, often funded by international development funds, this research adds useful insights into current practices, and improvements in the practical implementation that could enhance both the design of interventions, as well as community resilience to climate change.

ABSSUB-1396

Adding the scenic benefits as an element in cost-benefit analysis of green roofs

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Research question: Green roofs have gained popularity as part of sustainable urban solutions, with special reference to climate proofing benefits (energy saving and storm water retention). Yet, hitherto reported social cost-benefit analysis of green roofs include various strong assumptions or even skip certain elements. In this study we introduce better founded estimates for the scenic value of green roofs, whereas we also account for the volume dependent anti-costs and benefits of green roofs.

Methodology: We use a large data base with about 7000 real estate transactions and details on land use features and natural and other amenities in the Helsinki downtown area. We employ hedonic pricing theory, implemented via spatial regression models, and green roof implementation scenarios in order to estimate the aggregate willingness-to-pay for a 'unit' of green roof.

Findings: When adding up private and public benefits, the benefits would surpass the costs in most of the cases, especially if the assumption that a higher implementation rate drives down the costs is realized. Scenic benefits have a potential to be a significant factor in green roof CBA; even inclusion of the lower limit of the estimate of aggregate WTP would drive the level of benefit higher than the costs even in the high cost-low benefit-scenario.

Significance for practical solutions: We illustrate by means of a moderate and an ambitious implementation scenario that from a societal point of view it would pay off to achieve fairly high shares of green roofs in downtown Helsinki, possibly up to 50% of the downtown roof top capacity.



ABSSUB-1305

Guidelines for adaptation to climate change in city planning and spatial design

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Research question: With this study the Flemish Spatial Planning Department wants to combine basic information, policy principles, guidance and examples with regard to the role of spatial planning in adaptation to climate change of urban or peri-urban areas. The objective of the study is to develop qualitative and quantitative guidelines for adaptation to climate change in the fields of spatial planning and urban development. The study also has the ambition to develop an integrated vision of sustainable adaptation to climate change, and the role that spatial policy has to play in this respect.

Methodology: The first phase of the study consists of a detailed analysis of existing literature on the impact of climate change in Flanders under different climate scenarios. It includes an analysis of the importance of the effects and of the (spatial) factors that determine their impact and its spatial differentiation. As a part of this phase, the specific vulnerability to climate change of different (urban) areas in Flanders is visualised. Next, adaptation measures are developed and refined on the basis of research by design, and applied to a number of pilot areas in the Antwerp and Brussels metropolitan regions.

Findings: The study has resulted in the definition of both general guidelines and a set of concrete adaptation measures that are applicable at several spatial and institutional levels. Focus has been on measures on a citywide to regional scale, which is a larger scale than the one typically used in the definition of adaptation measures. The study focused on multiple benefits of adaptation, including social and societal benefits and the benefits in the field of biodiversity and spatial quality. It includes recommendations regarding collaboration at different governance levels, data availability and exchange, and coordination.

Significance for practical solutions: The study results include a portfolio of practically applicable solutions at different spatial and governance level, detailing their characteristics, (co)benefits, advantages and disadvantages. This allows practitioners to choose from a wide array of possibilities taking into account preferences and possibilities. The study also highlighted the potential of research by design as a practical tool for developing sustainable and widely accepted adaptation solutions.



ABSSUB-1067

Demonstrating adaptation: the pivot towards climate adaptive storm water management in Miami Beach

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Research question: How did the city of Miami Beach, Florida identify and overcome common adaptation barriers in its first year of implementing a \$300-\$500 million sea level rise and climate change adaptive storm water system?

Methodology: Meeting minutes, participant observations, and open ended interviews are used to create a timeline of planning and implementation actions. These sources, along with the timeline, are analysed using urgency and risk frameworks to create a longitudinal description of the city's actions, barriers that arose, and risks identified by key players. Analysis and results are structured around seven previously identified barriers to facilitate comparison with other cities.

Findings: We find that barriers follow adaptation actions and were addressed dynamically by the city. Miami Beach's storm water management project was initiated by a new mayor during a financial upturn, avoiding two common barriers: leadership and unstable finance. Actions taken during the first year were impacted by other barriers including fragmented decision making, institutional constraints, and divergent risk perceptions. Despite an identified need for a comprehensive long-term response to sea level rise, most actions taken in the study period can be characterised as demonstration projects. These projects have short term impact, are visible to stakeholders, help communicate the administration's story that it is dealing with flooding, and are within the city's area of responsibility so require minimal cross-jurisdictional collaboration. The use of demonstration projects was driven by the city's two-year election cycle and the need to justify an 80% increase in storm water fees to citizens. To maintain urgency and legitimacy, it was important for the city to be seen doing something effective in the first months of a five-year project. Through our risk analysis, we find that the economic threat of sea level rise was the primary driver for leadership and investment decisions. However, addressing sea level rise as an environmental threat to the city became increasingly important over time. Acknowledging environmental risks facilitated collaboration between departments while building local and regional legitimacy for implementation of new adaptive solutions.

Significance for practical solutions: Local governments can use multiple demonstration projects to overcome short-term barriers and build support for implementation of longer-term adaptation efforts. Describing or framing adaptation projects in terms of economic risks is an effective motivator for initial implementation. Describing projects in terms of environmental risks enhances implementation by encouraging collaboration within city government and building external legitimacy with citizens and other governments.



ABSSUB-1303

DESIGN GUIDELINES FOR THERMALLY COMFORTABLE AND ATTRACTIVE STREETSCAPES IN HARBOUR AREAS

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Research question: The redevelopment of harbour sites into new living and working areas is typical for urban densification worldwide. Cities are facing environmental challenges in response to deindustrialisation, urbanisation, as well as global warming. The challenge is to convert harbour sites into thermally comfortable and attractive spaces. Urban vegetation positively affects people's thermal perception and enhances people's aesthetical appreciation of outdoor spaces in residential areas as earlier findings suggested. Yet, the spatial context of a harbour area has not been the focus of a study to date. But urban designers need to know how to optimally re-design streetscapes by means of street greenery in order to improve thermal conditions and attractiveness in harbour areas.

This research aims to develop evidence - based design guidelines for thermally comfortable and attractive streetscapes.

Methodology: To reach that aim we investigated impacts of three types of street greenery (low horizontal vegetation, green facades and street trees) on people's long-term thermal perception and aesthetic appreciation in a harbour context. The case area was the Merwe-Vierhavens in Rotterdam, The Netherlands (in collaboration with the municipality of Rotterdam). We conducted online and face-to-face surveys in the city in 2014. For four typical harbour zones (port-industrial; new business; residential; residential waterfront) different green types (no vegetation, ground vegetation, wall vegetation, trees) were simulated in photorealistic images. These images were visually evaluated by local people (N=106). Survey data were analysed using descriptive statistics and thematic coding.

Findings: Our findings indicate a positive impact of street greenery on long-term thermal perception and attractiveness in harbour areas, confirming earlier findings. From all investigated green types, trees were top-ranked for improving thermal perception (mean 3.84) and attractiveness (mean 3.68) on a scale range of 1-4; whereas no vegetation in all zones was ranked lowest. Low and wall vegetation was evaluated similarly for both aspects. Based on the survey results we recommend to use ample street greenery, especially trees, in the re-design of harbour areas. Furthermore, in new business and residential areas green facades and ground vegetation should be implemented. But in residential waterfront and port-industrial areas 'open views' with ground vegetation and few trees are preferred.

Significance for practical solutions: Our results provide urban designers with suitable types of street greenery for various harbour zones. By applying these design guidelines in former harbour areas, new living and working areas with thermally comfortable and attractive streetscapes can be created. That way, we contribute to the re-development of harbour areas into more liveable urban environments in growing cities.



ABSSUB-1103

Urban adaptation planning in Asian coastal megacities: Jakarta as a case study

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Research question: The impacts of global climate change that coastal megacities in Asia are facing include flooding, sea-level rise, intensified storm, and storm surges. These impacts may result in loss of life and the damage of housing, infrastructure, regional, and national economies. By studying vulnerability maps and analysing the climate change vulnerability index across Southeast Asia one can see that Indonesia and in particular Jakarta immediately stand out. Jakarta is one of the most vulnerable cities in the world to climate-related disaster. The most severe impacts in Jakarta are increased flood frequency, drought, sea-level rise, and landslide exposure. It is forecasted that, if global warming continues at its current rate, some areas in Jakarta will be inundated by 2050. Furthermore, many other areas in North and Central Jakarta are likely to be submerged in the future, which will cause major suffering for residents as a result of physical and socio-economic impacts. Urban adaptation planning is of crucial importance when it comes to protecting Asian coastal megacities like Jakarta and their inhabitants. The main objective of this research is to explore the problems of urban adaptation planning by local institutions and governments in Jakarta.

Methodology: In order to explore the problems of urban adaptation planning in Jakarta a model is used to identify and compare the different types of adaptation planning in the region. This model distinguishes between actors, data, objectives, target groups or regions, approaches, results and shortcomings.

Findings: The results found by this research show that the main problem of urban adaptation planning in Jakarta is the overall lack of coordination between local institutions and governments. Another problem is that climate risk assessments have been conducted by different research and government institutions in a disintegrated way. Furthermore, there appears to be no connection between risk assessment and urban development. The shortcomings of local institutions and governments are demonstrated by the fact that multiple cases have been found of local communities that prefer to manage their own adaptation planning versus those provided by the government.

Significance for practical solutions: This research may be of importance to the field of urban adaptation planning in Jakarta and other Asian coastal megacities because it analyses current problems and comes up with practical solutions. The main finding of this study shows that when it comes to urban adaptation planning in the case of Jakarta there is a serious need for more coordination and connection among communities, institutions, and governments.



ABSSUB-376

Challenges for urban resilience: the global crisis of urban water

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Research question: Is there a global water crisis in the making?

An issue of vital importance that challenges urban resilience are the crisis of urban water. These problems begin to evolve rapidly in a context of climate change and variability. The problems are manifested in issues related to water quantity, quality, as well as in impacts of water shortage on electricity production. Moreover, climate change leads to changes in rainfall patterns, and tend to increase extreme water-related phenomena, in particular rapidly changeable patterns of cycles of droughts and floods. These water crisis are being experienced by megacities and urban regions all around the globe, from Sao Paulo to California and Mumbai. These changes in patterns of droughts and floods are challenges in urban resilience that pose enormous problems to the stability of cities all around the world. Facing these challenges requires changes in the dominant technological paradigm, in governance arrangements and in the aesthetics of resilience. I propose a planning process to address these problems from the perspective of social innovation for lasting change.

Methodology: The planning process for social innovation and social enterprise in urban water. The main steps of these process include: formulation of the problem; the description of the hegemonic paradigm to address these problems; the limitations of the paradigm; a search for alternatives; some illustrations; the implementation; and, issues of governance.

Findings: The hegemonic paradigm is insufficient to respond to urban water crisis.

Significance for practical solutions: The traditional paradigm has become incapable to address complex water problems in the context of climate change. This opens an opportunity to search for alternatives through establishing a link between the watersheds that feed dams, urban issues, and urban water infrastructures.



ABSSUB-300

Can mangroves help combat sea level rise through sediment accretion and accumulation?

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Research question: Mangroves have substantial roles to induce sedimentation in the vulnerable coastal regions, which subsequently helps to combat climate change induced impacts like sea level rise. Although Sarawak has numerous pristine estuarine mangroves, studies on the roles of these mangroves in regards to sediment deposition are scanty. Hence this study is undertaken.

Methodology: This study was carried out to determine the sediment accretion and accumulation pattern of pristine Sibuti mangrove in Sarawak, Malaysia using tiles and sediment traps for one year from January to December 2013.

Findings: Monthly average accretion and accumulation rate of sediments of this mangrove were 0.55 mm and 0.08 g cm⁻², respectively. A total of 6.56 mm and 0.93 g cm⁻² sediments were accreted and accumulated annually. Significantly positive correlation ($r=0.794$) was found for the monthly accretion of sediments with accumulation. Accretion and accumulation of sediments were also positively correlated with rainfall. Comparatively higher rate of accretion and accumulation of sediments were estimated in the months of wet season when the rainfall and tidal inundation duration were high. Erosion was found higher in the months of dry season when the rainfall was low. Seasonal variations were not found for sediment accretion as well as accumulation in the study area.

Significance for practical solutions: The findings of the study suggest that the roles of this forest in regards to sediment accretion through retention is compatible with the predicted annual rate of sea level rise of 1.8 to 5.9 mm within 21st century by IPCC.

ABSSUB-1193

Effects of climate change on natural resource base of the Valley bottoms in central Kenya region

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Research question: The Central Kenya region contains the most extensive high altitude areas in Kenya with the Mt. Kenya and Aberdare ranges being the largest natural forest ecosystems in the country. The two ecosystems are sources of water for major rivers that extend long distances into the Indian Ocean. The region is criss-crossed by intersecting challenges of land use changes, climate change, food insecurity, intra national instability, increased degradation of forest and water resources and resource user's conflicts. This has presented a unique challenge for the national and devolved government system. As vagaries of climate change continues to affect the region coupled with increasing human pressure, there is a tendency for the communities to move to the valley bottoms and wetlands areas to cultivate food and fodder for their



livelihood. While water is the main driver and modulating factor in the nature of a wetland, soil characteristics and the changing climate are seen to largely determine the agricultural production and the resilience of the system.

Methodology: A study was carried out in five valley bottoms and wetlands in Central region to investigate the contribution of climate variability on the extent of agricultural use, the water volume, crop productivity and resource use conflicts. Random sampling was done to identify the farms to sample along and across the valley bottoms in the selected sites. Observations included the land uses and changes in different seasons, extent of expansion of the land uses, volume of water in along the streams and yield of crops in the sampled farms. The livelihoods of the farmers and upland land uses were also examined.

Findings: The results revealed that extent of agricultural land uses increased during the dry periods of the year. This included crop cultivation, fodder harvesting and grazing. The expansion of cultivated land positively correlated with resource use conflicts between livestock keepers and farmers. Crop productivity per unit area was not enhanced in the valley bottoms as was expected although there was a high diversity of crops grown in the valley bottoms compared to the uplands. Uncertainties regarding the rainfall period (length and amounts) meant that the farmers continued cultivating in the valley bottoms which were later destroyed by unexpected flooding.

Significance for practical solutions: There is need for capacity building of the communities living in these areas on cultivation during the dry season and conservation of the riparian trips to reduce the level of destruction caused by river flooding. However, valley bottoms and wetlands remain a bread basket of most marginal regions in Kenya.

ABSSUB-1448

Future potential productivity: an analysis of global crop yield using process based model

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Research question: With a growing global population, predicting future crop production and the uncertainty under future climate change in global scale is of paramount importance for food security. The purpose of this study is to evaluate the possible crop yield under future climate change for soybeans and maize using process-based crop growth model (Sakurai et al. 2014). One of the difficulty in estimating the future possible yield is the evaluation of the available capacity of yield increase. For this purpose, we estimated the "cultivation-technology-parameter" for each spatial grid (1.125° × 1.125°) by using Bayesian statistical approach. Using this parameter, we estimated possible crop productivity under future climate change and SSP scenarios. We also discuss about the key countries that have large available capacity for technological increase for sustainable crop productivity.

Methodology: The spatial variability of model parameters was considered by estimating the distribution of the parameters from historical yield data by using the Markov-chain Monte Carlo (MCMC) method. The datasets of maize and soybean yields during 1982–2006 with a spatial resolution of 1.125° × 1.125° (Iizumi et al. 2013) were used for this purpose. The posterior distributions of model parameters were estimated for each



spatial grid with 30 000 MCMC steps of 7 chains.

Findings: The estimated global average of future crop yield reached a ceiling around 2050 for both soybeans and maize for any SSP scenarios. The estimated cultivation-technology-parameter were higher in the United States among the major producing country for soybeans and maize. China and South Africa had relatively large available capacity for yield increase for soybeans. Brazil and Africa had relatively large available capacity for yield increase for maize.

Significance for practical solutions: The yield increase in these countries would be the key factor for sustainable crop productivity.

Iizumi, T. et al. (2013) *Global Ecology and Biogeography* 23: 346-357.

Sakurai, G. et al. (2014) *Scientific Reports* 4(4978): 1-5. doi:10.1038/srep04978

ABSSUB-859

Smallholder farmers' perception of climate change and strategies to facilitate climate smart farming

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Research question:

1. What are the socio-economic characteristics of respondents?
2. What do smallholder farmers understand by climate change, and what are the sources of climate change awareness?
3. What are smallholders' perception of climate change?
4. What are the coping strategies used by smallholder farmers to counter the effects of climate change on crop production?

Methodology: One agro-ecological zone, namely Osun from South Western Nigeria was selected. Two blocks were chosen from the selected agro-ecological zone, and out of the blocks chosen, four cells comprising of 20 arable farmers each were selected making 80 arable farmers. Structured questionnaires were used to interview farmers. The data collected were analysed using frequency counts, means and percentages. A 4-point Likert type scale of strongly agree, agree, disagree and strongly disagree with assigned weight of 4,3,2,1 respectively was used to measure the effect of climate change. In calculating perception of the effect of climate change, the mid-point values of the scale were summed up and further divided by 4 to obtain mean of 2.5. The mean of the perception of the effect of climate change was obtained by multiplying the point scale by the number of respondents in each point scale. Any perception of climate change with a mean score of equal or above the cut-off mean of 2.5 was regarded as agreed with the statement indicated and any mean score lower than 2.5 was regarded as not agreed with statement.

Findings: Findings indicate that majority of the respondents were between 61 and 70 years (53.8%); male (62.5%); married (92.5%); had a household size of about 7 (64.8%); had no education (48.8%); farm size (47.5%) of not more than 2 ha. Majority (95.5%) of the respondents understood the term climate change. About 95% of the respondents observed climate change in one form or the other. Personal experience (92.5%) and Radio (83.8%) were the most important sources of awareness of climate change by respondents.



Respondents also noticed the effects of climate change between 1 to 5 years ago. Respondents stated that there had been extreme change in weather and that increase in temperature and unpredictable rainfall pattern have the highest effect of climate change. In addition, respondents posit that there had been longer heat stress, drought, outbreak of pests and diseases as well as health hazard (perception mean of 3.2 each). Result also showed that respondents experienced reduction in the yields of crops (mean of 3.5). The adoption of multiple cropping practice was the most used strategy by farmers to diversify their production and livelihood (mean of 3.5). This finding is in agreement with Molua (2008) and Apata et al (2009). Other strategies identified to be effective include crop rotation (mean of 3.2) and mulching (mean of 3.1).

Significance for practical solutions: The intended outcomes of the research is to build capacity in a group of smallholders to adopt climate smart practices and also to refine existing practices and technologies to increase adoption.

ABSSUB-1244

Rural livelihoods and cropping pattern under climate change in the Zio District of Togo, West Africa

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Research question: The general objective of this paper is to assess the situation of farmers' livelihoods in relationship with cropping pattern under climate change in the Zio district of Togo, West Africa. To this end, some questions of interest were asked:

1. How do farmers perceive and understand local climate change?
2. What are the determinants of climate adaptive strategies' in relationship with cropping pattern in the study area?
3. What is the situation of farmers' livelihoods in a changing cropping pattern?

Methodology: As methodological approaches, this paper was based on Sustainable Livelihood Framework of DFID, two steps Binary Logistic Regression Model and descriptive statistics. The first step regression which is the selection model was used to analyse farmers' perception of climate change while the second step, the output model was used to look at the determinants of farmers' adaptation strategies to climate change. Based on Sustainable Livelihood Approach (SLA), various factors revolving around the livelihoods of Zio rural community were grouped into social, natural, physical, human, and financial capital; and indicators were developed to assess each asset.

Findings: The result from descriptive statistics and the selection model indicated that farmers in the study have clear understanding of climate change even though they don't have idea on the main cause behind the issue which is greenhouse gases. The output model result showed that education, farm experience, access to credit, membership of a social group, distance to the nearest input market, local knowledge to predict seasons and soil fertility status were significantly related to the adaptation strategies used by farmers in the study area. Regarding the livelihood situation of farmers, the study found that the overall livelihood index in the Zio district is below the average (34%) with natural capital as the poorest asset, and this will severely affect the sustainability of livelihood in the long run.



Significance for practical solutions: This paper is based on practical approach. This study by applying the Sustainable Livelihood Approach which is widely used for rural development issues around the world, identified not only what farmers need to improve their adaptation to climate change but also what their have as resources, skills, capacities and knowledge. Based on the result of this paper, specific recommendations are made to farmers themselves, policy makers, institutions and development service providers in order to better target interventions which build, promote or facilitate the adoption of adaptation measures with potential to build resilience to climate change and then improve rural livelihoods.

ABSSUB-208

Measuring vulnerability index for climate change impact on agricultural production in India

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Research question: Managing climate variability and the impacts of climate extremes on land and water resources is one of the challenges that need to be addressed in an integrated manner. Indian agriculture is primarily dependant on monsoons, and any variation in the rainfall patterns is likely to impact the agricultural production. paper focuses on the development of vulnerability index in the Godavari river basin districts in India. The paper also suggests some adaptation measures to increase resilience and agricultural productivity.

Methodology: A composite index from multivariate data is worked out and based on the index, all the districts falling within the river basin are ranked in terms of their vulnerability to climate change. Vulnerability to climate change (CC) is a comprehensive multidimensional concept affected by large number of related indicators. These could be related to market, population and other socio-economic factors that act simultaneously together with climate change. Composite indices are used as yardsticks to gauge the vulnerability of each region to Climate change.

For quantifying the impact of climate change on agricultural production in the sample districts the Ricardian type model is applied keeping in view in its merits over other models. The vulnerability index and Ricordian model is applied for 10 districts of Andhra Pradesh state in India.

Findings: Study showed areas ranging from vulnerable to very highly vulnerable under Godavari basin. As per the study 59.2 percent of the area affected due to the selected five vulnerable components. Out of 10 sample districts, districts especially in the middle and upper parts of the Basin are more vulnerable to climate change. Prominent climate variables such as long term rainfall average, long term minimum temperature average, long term daily maximum temperature average which are influencing production of paddy are shown. The variables total crop, proportionate irrigated area, long term maximum temperature average led to significant reduction in the paddy area. In case of maize production , the model is adequate as it is shown by F-Statistics of ANOVA. The R square value is 0.16 or 16 per cent of variation in the maize production as result of variation in the climate change. The variables RLT, HLT and Yield of Maize are highly significant variables in affecting the area of maize.

Significance for practical solutions: Our results provides a platform for policy makers and agriculturists to envisage policy directions to face variable climate change impacts on agricultural production in the river



basin. Our study also recommends introduction of weather based crop insurance programmes, input subsidies and construction of storage structures in key regions where rainfall run of high can be aimed at. Study also recommends importance of climate awareness amongst farmers and coping measures should be an integral part of the development programmes at all levels.

ABSSUB-587

Gender and climate change adaptation technology needs of oil palm farmers in EDO State, Nigeria

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Research question: Nigeria is noted for oil palm (*Elaeis guineensis*) production and Edo state was the major producing State. Production has witnessed a downward trend over the years which could be attributed to the challenge posed by climate change to agriculture and the environment. Oil palm value chain comprises of various activities. Males and females are involved and affected differently by climate change hence need for adaptation technologies. This study therefore assessed climate change adaptation technology (CCAT) needs of oil farmers in Edo State, Nigeria. It specifically by gender described the respondents' socio-economic characteristics, involvement in oil palm value chain, utilization of CCATs, sources of information, constraints utilization of CCAT and climate change adaptation technology needs of oil palm farmers.

Methodology: A sample of 120 respondents was selected through a multistage process. Data were collected using a structured questionnaire and analysed using descriptive and inferential statistics

Findings: Findings show that oil palm farming in the study area was dominated by the males headed households (78.8%). Majority of the respondents had farm size of <4. ha, average family size (06). Both male and female oil palm farmers were highly involved in oil palm value chain activities. Sources of information mostly accessed by the farmers were friends and family (=2.83) and radio (= 2.16). Major challenges faced by both genders but more serious for female respondents to effectively utilize CCAT include inadequate capital (= 2.86), poor access to land (= 2.76), inadequate storage facilities (= 2.76), high rate of illiteracy level (= 2.66) and poor extension service (= 2.60). Both genders perceived CCAT technology/information were mostly needed in marketing period/location (= 2.93) and optimum plant population (= 2.91). There was significant relationship between farming experience ($r = -0.301$), size of farm ($r = 0.265$), income ($r = 0.214$) and utilization of CCAT at 5% level. There was also significant difference between the male and female respondents with respect to technology need expressed ($t = 7.98$).

Significance for practical solutions: The study therefore concludes that climate change adaptation technologies/information would be better utilized if credible sources disseminate them. If the constraints to utilization of climate change adaptation technologies (CCATs) are addressed and farmers' capacities are built by agricultural extension workers, while women are targeted in relevant activities, oil palm value chain could witness a boost in Edo State.



ABSSUB-189

Mapping of multiple stressors contributing to vulnerability across scales in semi-arid zone of Ghana

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Research question: Smallholder farmers in sub-Saharan Africa are confronted with climatic and non-climatic stressors. However, research attention has focused on climatic stressors with little empirical studies exploring non-climatic stressors and how these interact with climatic stressors to affect food security and related livelihoods at multiple scales. A focus on climatic factors alone restricts understanding of the combinations of stressors that exacerbate the vulnerability of farming households. This gap hampers the development of holistic policies aimed at integrating non-climatic stressors into the design of climate change adaptation policies. This study addresses this gap by adopting a multi-scale approach in identifying climatic and non-climatic stressors and how these stressors interact at three different spatial scales (household, community and districts) in 3 selected case study villages in semi-arid zone of Ghana. More specifically; this study answers the following research questions: (i) what existing climatic and non-climatic factors contribute to vulnerability of households in semi-arid zone of northern Ghana? (ii) how do the climatic and non-climatic stressors vary across different spatial scales? (iii) in what ways do climatic and non-climatic stressors interact at different spatial scales to exacerbate vulnerabilities of livelihoods to climate change?

Methodology: This study utilises a series of participatory tools including household surveys, key informant interviews and focus group discussions. The incidence index, importance index and overall joint risk index for the key stressors identified at the household, community, and district levels are calculated. Severity index is determined by the number of pebbles assigned to a particular stressor by respondents in household surveys or community members during focus group discussions.

Findings: The results show that smallholder farmers in different communities perceived climatic and non-climatic stressors differently; yet, there were a number of common stressors including lack of credit facilities, high cost of farm inputs, erratic rainfall, and lack of agricultural equipment that cross all scales. Results indicate that other socioeconomic factors including gender and age also influenced the perception and severity assessment of stressors on rural livelihoods and food security at the household, community and district levels.

Significance for practical solutions: The findings highlight the significance of tackling both climatic and non-climatic stressors including rural unemployment, lack of markets and poor village infrastructure. Findings suggest a mismatch between local and district levels priorities and this has implications for policy and development of agricultural and related livelihoods. The paper contributes to adaptation and vulnerability assessments by highlighting the way scale interacts with perception of stressors. The implications of the findings are discussed in the light of climate change policy development in sub-Saharan African countries.



ABSSUB-524

Mapping experience and adaptation to climate change across two semi-arid rural sites

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Research question: The present study is conducted in two rural contexts (Mewat in Haryana and Tikamgarh in Madhya Pradesh), both located in semi-arid zone with agriculture as a dominant livelihood. The study has three objectives: a) To understand the community's perception of frequency and extent of changes observed in the climate variables and agricultural resource base. b) To analyse the impact of multiple stressors (including climate) that bring about social vulnerability by altering the availability of water and disruption of agrarian livelihoods. c) To examine adaptive measures undertaken by the community members in the background of perceived changes, and the action of non-climatic stressors.

Methodology: Two villages from each district were chosen randomly. Purposive stratified sampling technique was used to select households so as to include diverse responses from different groups (such as women, farmer groups according to class size, landless, farmers with tube well, and farmers without tube well). The sample is statistically representative of relevant groups in the population. For analysis, basic statistical analysis was applied along with analytical discussion of observed and recorded qualitative findings from the field.

Findings: The evidences of present and future vulnerability to climate change in the study villages suggest change due to both- direct exposure to climate extremes and its indirect impact on the agricultural resource base. The first reason directly links the source of vulnerability to climate extremes, for example the instance of continuous drought or flood in Tikamgarh. Human action based on community perceptions may also give rise to events or circumstances that increases the vulnerability to future climate changes, as observed in Mewat through change in crop choices, use of saline groundwater for irrigation and land use changes. In the four study villages, it is established that the farmers' adaptation measures are based on short-term changes in the climatic variables. Lack of support due to the absence of knowledge institutions has prevented planned adaptive measures to long-term climate change phenomenon. Nevertheless, there are evidences of proactive adaptive measures but limited in extent. It can thus be concluded that climate variability works in conjunction with other forms of stressors to describe changes in the resource base as observed and responded to by the communities.

Significance for practical solutions: The model employed in the paper highlights action of multiple stressors and brings out distinction between the nature of vulnerability across study villages. An understanding of stressors as a mediator between climate change impacts and community responses is found to be useful for intra-regional comparison and has the potential to contribute towards informed decision making for climate action.



ABSSUB-1153

Improving climate change adaptation practices: lessons from smallholder commercialisation in Ghana

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Research question: The idea and practice of smallholder commercialisation has become increasingly attractive for smallholder agricultural development. However, it has not yet been sufficiently recognised and discussed in the context of climate change adaptation. This raise the question: What is the potential of smallholder commercialisation for climate change adaptation, and livelihood improvement of smallholder farmers in Ghana?

Methodology: In this research a case study approach was used. In order to determine what impact smallholder commercialisation have on adaptation, primary data for the study were obtained from 150 smallholder farmers in the Akuapim South Municipality and 3 key informant interviews. Secondary data was also obtained from the Municipal Agricultural Office. Data collected were analysed using SPSS, with chi square used to test for associations.

Findings: The results of the study showed that the characteristics of smallholder commercialisation enhance climate adaptation of smallholder farmers. The result also revealed that level of knowledge/education as well as training plays an important role in increasing adaptation of smallholder farmers. furthermore it was established that commercialisation also decreases the livelihood vulnerability making farmers better protected against climate shocks and stresses.

Significance for practical solutions: The study established that smallholder commercialisation offers beneficial guidelines for the design of climate adaptation programmes. It also goes to show that there need to be a fresh approaches of looking at adaptation.



ABSSUB-239

Coping with climate variability and water stress in rainfed farming of India: a study

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Research question: Rainfed agriculture remains the major source of staple food to poor farming community of India. The rainfed farming is the most vulnerable to climate change. The changes in rainfall and temperature regimes affect water availability and agricultural productivity. The production uncertainty due to frequent crop failures jeopardizes the livelihoods of small farmers. A micro-level investigation attempts to evaluate the vulnerability and farmers' adaptive capacity to cope with climate variability in rainfed farming in eastern plateau region of India.

Methodology: The study is based on field surveys of 8 villages, interviews of 750 farm families and interactions with 5 institutions to generate a cross-section data base of a micro-watershed (study area) of the region. Secondary data is collected from the government literatures and statistically analysed for interpretation.

Findings: The findings reveal that farmers' perceptions of climate risk and their choice of coping strategies are mostly influenced by socio-economic and political factors. Results of multivariate discrete choice modelling indicate that access to credit, extension services on climatic and agronomic information, and awareness on climate change issues at community level are some of the important determinants of farm-level adaptation. Farmers experience the shifts in rainfall pattern and water stress in rice growing season over the years, consequently the havoc loss in rice production fails to support their livelihoods. Farmers are gradually adapting to climate change through innovations in agricultural management practices like crops diversification, mixed farming, varying planting dates and water conservation techniques, and their adaptation options are independent of the state support. Integrated crop-livestock farming becomes adapted to farmers as a coping strategy against climate risk and crop failures. Moreover, farmers also need to make conscious decisions to adapt based on their analysis of livelihoods risks. Rainwater harvesting is the most popular risk management strategy, showing its potential of greater success among small farmers. However, the building of skills and knowledge capacity of agricultural stakeholders is urgently needed for efficient management of rainwater to address water stress. The findings also suggest that government policies should support research on developing drought tolerant crop-variety, effective catchment technologies and improving climatic information forecasting and awareness.

Significance for practical solutions: The study indicates that vulnerability of climate change on agriculture is unambiguous, however, the exact magnitude and adaptive capacity of small farmers to climate change is a complex interactions of technology, socio-economic and policy factors. Therefore, the policy framing, conducting research and promoting cost-effective adaptation options to small farmers can significantly increase subsistence farmers' adaptation to future climate change.



POSTERS - THEMES

2. FOOD, FORESTRY AND RURAL LIVELIHOODS



ABSSUB-386

Assessing rural farm households perception and adaptive capacity to climate change in Nigeria

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Research question: It becomes very necessary for government at all levels to put in place effective and efficient save net strategies that will mitigate the adverse effects of climate change on the rural farm households'. Therefore, this study will provide answer to the following research questions: How do rural farmers' in the study area perceive climate change and do they have the adaptive capacity to mitigate the effects of climate change?

Methodology: The study was conducted in Ekiti, Ondo and Oyo State. All the States are in the Southwestern Nigeria. A multi-stage sampling technique was used to collect data for the study. Three hundred and sixty (360) rural farmers' were interviewed for the study. Data were collected with the aid of structured questionnaire. This is with the aim of taking advantage of Agro-Ecological Zones (AEZs) in these States to determine the adaptive capacity of rural farm households' to climate change risks. To determine the rural farmers' perception of climate change, 5-point Likert-type scale was used. Also, weather variables trends from 2000 to 2013 were used to confirm the rural farmers' perception of climate change. Again, to determine the adaptive capacity of the rural farm households' to climate change risks, Livelihood Diversification Index (LDI) was calculated; higher diversification indicating high adaptive capacity.

Findings: The responses of the rural farmers' in the Guinea Savannah (GS) AEZ to the perception statement of what they understand by climate change revealed that they had positive perception towards high intensity of sun, high degree of temperature, frequent rainfall and unusual drought statements with the grand mean values (X) of 3.88, 3.88, 3.52 and 4.18 respectively. Also, the responses of rural farmers' in the Rain-Forest (RF) AEZ revealed that they had positive perception towards frequent rainfall and incessant flood statements with the grand mean values (X) of 3.76 and 3.78. The study further revealed the staggering pattern in the mean inter-annual temperature of the GS AEZ, ranging from -0.08°C to +0.73°C deviation from the baseline mean annual temperature. Also, there was high inter-annual rainfall variability in RF AEZ. The rainfall varies between -319.68 mm and +396.12 mm. The study further revealed that there was significant correlation between the solar radiation and relative humidity at seasonal and annual levels in the study area. The LDI revealed that in the GS AEZ, 19.4% of the respondents have low adaptive capacity (i.e. 80% income is from farming). 23.3% of the respondents in the AEZ have very high adaptive capacity (i.e. > 80% of their income is from non-farming activities). Also, in the RF AEZ, 14.4% of the respondents have very low adaptive capacity and 48.4% have very high adaptive capacity.

Significance for practical solutions: The study will guide government at all levels in formulating policies that will mitigate the effects of climate change on the rural farm households' and this ensure food security in Nigeria.



ABSSUB-619

Women's adaptive innovations in land and water management under climate change in Himalaya

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Research question: In Himalaya, due constraints of subsistence agricultural economy large proportion of male population out-migrates. Hence, women are primary resource developers and backbone of mountain economy. Climate change has stressed agricultural-system, and increased community vulnerability to food and livelihood insecurity. Women, experience these changes disproportionately and respond them in varying manner because of socially constructed gender relations. However, feminization of agriculture facilitated women to develop critical knowledge in agricultural resources management and adaptation to climate change. Paper analyses adaptation mechanism evolved by indigenous women, and assesses its impact on their participation in decision-making and empowerment in agricultural resources with case illustration of Kumaon Himalaya.

Methodology: Study employed comprehensive socio-economic survey techniques and empirical field observations methods.

Findings: Results indicated: (i) women in 27% villages replenished water sources employing traditional water conservation practices; (ii) 19% women changed cropping pattern, (iii) women in 25% villages developed indigenous rainwater harvesting system; (iv) 21% women adjusted crop-rotation; and (v) 27% women relocated agriculture; (vi) 55% women taking all decisions related with land and water management; and (vii) 37% women take decision for utilization, processing and marketing of agricultural products.

Significance for practical solutions: Thus, women's innovative adaptation measures are not only building climate change resilience in mountain farming but also reducing gender-gap that could have significant implications in other mountains regions of the world, particularly in poor and marginalized regions.



ABSSUB-1071

Adaptive capacity and factors that influence adaptation strategies among Kassena Nankana farmers

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Research question:

1. What factors contribute to the adaptive capacity of farming communities within the Kassena Nankana Municipality of Ghana?
2. How different is the level of adaptive capacity among farmers in the three communities studied within the municipality?
3. What are the adaptation strategies farmers employ in response to climate change?
4. What socio-economic factors significantly influence the adoption of adaptation strategies among farmers in the three communities studied within the Kassena Nankana Municipality?

Methodology: The study employed a mixed-method approach by purposively surveying a total of 155 farmers from three communities (Korania, Nayagnia and Manyoro) within the Kassena Nankana Municipality of Ghana complemented with secondary data on rainfall and temperature trends within the municipality.

Findings: The results indicated that most respondents were within the ages of 35-54; 59.4% had no formal education. A linear regression model revealed that in the last 30 years, mean temperatures within the municipality had been increasing at an annual rate of 0.02°C, while mean rainfall totals had declined at an annual rate of 0.15mm. The analysis of adaptive capacity was based on use/access to five capital assets (human, financial, social, physical and natural). The three communities demonstrated different degrees of adaptive capacity although they were within the same agro-ecological zone. An index of $0 < AC < 0.33$ was considered as low, $0.33 < AC < 0.5$ as moderate and $AC \geq 0.5$ as high. The overall mean adaptive capacity of the study area was moderate ($AC = 0.43$). Manyoro recorded the highest adaptive capacity score of $AC = 0.44$ while Nayagnia recorded the lowest adaptive capacity score of $AC = 0.42$. The lowest and highest adaptive capacity scores of $AC = 0.21$ and $AC = 0.68$ were associated with financial and natural capitals respectively in Korania. Mixed farming, irrigation, soil conservation methods, and engagement in alternative livelihoods were among the main adaptation strategies adopted by farmers in the three communities in response to climate change, with mixed farming being the most important (practiced by about 74.8% of the respondents). A binary logistic model showed that sex ($p < 0.01$), educational status ($p < 0.05$), land ownership ($p < 0.01$), access to information on farming issues ($p < 0.05$), and receiving early warning on weather-related issues ($p < 0.05$) significantly influenced the use/access to a set of adaptation strategies.

Significance for practical solutions: The results indicated that farming communities within the Kassena Nankana Municipality of Ghana were partly affected by climate change due to their moderate level of adaptive capacity and socio-economic status hence, policymakers and other stakeholders should invest in the provision of modern storage technologies and give careful considerations to socio-economic factors in the choice of adaptation interventions promoted in the municipality.



ABSSUB-1059

Assessing vulnerability and adaptive capacity to potential drought for winter-wheat in China

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Research question: Drought is one of the major climatic disasters intimidating winter wheat production in the Huang-Huai-Hai (3H) Plain of China. The yield damage caused by drought tends to increase in the future, indicated by a pronounced uprising of drought events under RCP 8.5 scenario in terms of its affecting magnitude and area. A more clear understanding of the drought risks and their impacts is therefore necessary for better advising of adaptation options. Vulnerability assessment can identify vulnerable areas and the causes of vulnerability, which will constitute the basis for selecting adaptation actions to mitigate the adverse impacts. In such a process, the major difficulty is to accurately evaluate the impacts of drought in a quantitative manner. As it is very difficult to distinguish the individual impact of drought on crop yield from the integrated impacts of climate change under the current condition, we therefore focus on the impact of potential drought on winter wheat yield in this study. Study on the vulnerability of winter wheat to potential drought and associated irrigation effects are very helpful to understand the resilience of the production to drought, facilitating the development of adaptation to reduce the negative impact of drought on crop yield.

Methodology: A modelling approach by using crop model DSSAT and hydrological indices are applied to assess the vulnerability of winter wheat to future potential drought, based on an integrated assessment of exposure, sensitivity and adaptive capacity.

Findings: Our results demonstrate that Beijing, Tianjin, Hebei and Shandong are more exposed and sensitive to potential drought than other regions in 3H. Traditional irrigation has the greater benefits in northern 3H Plain than southern regions, but is still insufficient to impede the yield loss due to potential drought. Under RCP 8.5 emission scenario and the period of 2010–2050, the worst drought effect is projected to occur around 2030. More than half of 3H plain are subject to high drought vulnerability.

Significance for practical solutions: With increasing drought risks, we suggest immediate and appropriate adaptation actions to be taken before 2030s, especially in Shandong and Hebei, the most vulnerable provinces of 3H plain.



ABSSUB-489

A holistic approach to analysing farmer decision-making: implications for adaptation policy & practice

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Research question: Smallholder farmers operate within a risky and uncertain context. Uncertainties arise from climate variability and climate change, as well as social, environmental, institutional, and market-related dynamics and affect farmer decisions to cope and adapt. In this context, understanding how farmers make decisions to adapt is essential to successful policy and practice. In this paper, we present a framework to understand factors shaping farmer behaviour and how these are situated in pathways of response. Four facets of this framework to understand decision-making are examined: who makes livelihood decisions, why they are made, and how and when they are made. This approach conceptualises and explores household decision-making in a holistic manner, moving beyond previous studies that examine smallholder decisions through disciplinary boundaries (e.g. psychology, economics, risk management) or particular theoretical approaches (e.g. bounded rationality, theory of planned behaviour). The framework is tested using empirical evidence from Pratapgarh, a tribal-dominated rainfed district in southeast Rajasthan, India.

Methodology: The evidence is informed by ten months of ethnographic research in southeast Rajasthan, India, where data from 214 smallholder farming households were collected through a household survey using semi-structured questionnaires, in-depth interviews, focus group discussions and direct observation. Participatory tools like agricultural calendars, causal diagrams and risk ranking were also used.

Findings: The findings suggest that while resource ownership and access are the main drivers of decision-making, socio-cognitive factors such as perceived adaptive capacity and perceived efficacy to carry out adaptive actions are equally important factors mediating farmer responses. We also find that the holistic framework helps explain how personal motivations and individual perceptions of adaptive capacity interact with socioeconomic, climatic, and agro-ecological dynamics at local and regional scales to mediate risk perception and inform response behaviour.

Significance for practical solutions: Making a case for mixed methods to investigate farmer decision-making, we argue that a holistic framework is necessary to capture the complex and iterative nature of real farmer decision-making. This framework can be used by researchers, policymakers, and practitioners designing climate change adaptation projects to make improve uptake and scaling up of adaptation projects.



ABSSUB-305

Assessing community capacity towards climate induced water shortages in urban cities

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Research question: Within both academic field and professional practice of water management, there is growing interest in capacity of people, communities, and institutions to effectively manage water resources, both now and into future. Such concerns relate not only to inherent challenges presented by this critical and inherently variable environmental resource, but also to belief that climate be changing - and along with it, availability of water. Case analysis illustrates how general factors play out in local experience.

Methodology: Paper presents empirical analysis of local capacity for water shortage management in Visakhapatnam District whose population is 50 lakhs a fastest growing city in India. Paper combines conceptual notions of climate adaptation and capacity with empirically derived findings relating to a local experience in water management in order to document and interpret local strategies, identify conditions influencing resident in either local community or institutional realm, and draw out implications for understanding better those factors that enhance or limit community capacity. Evaluative frameworks developed to assist in local capacity assessment considering myriad actors involved in local water management and planning and consider capacity of a watershed community.

Findings: Study presented a summary of selected factors influential in capacity of communities to adapt to water shortages, expressed as indicator questions. How Institutional arrangements affect community's capacity to adapt to hydrologic variability by identifying and defining roles and responsibilities of core actors in water management highlighted. Study stressed that local organisations must have authority to select and implement adaptive measures. Key capacity related issues are targeted. Access to technical resources and current information of appropriate quality is essential for decision-making, planning, and implementation of adaptive measures highlighted.

Significance for practical solutions: The capacity evaluation undertaken in this study of water management relating to institutional arrangements, Community characteristics, and resources. Institutional arrangements may be useful to local organisations and NGOs.



ABSSUB-264

A waterharmonica to close loops and to enhance availability of fresh water and environmental values

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Research question: The world population is increasing to an estimated total of 9.7 billion people by 2050 (UN, 2015). This increase, together with an overall improvement of living standards, results in a growing demand for water, raw materials and energy (FAO, 2011). Currently, the demand for clean water is pressing in various (urbanised) parts of the world (Svedin, 2011; UNESCO, 2012). To forestall a shortage of clean water and to simultaneously adapt to climate change, the Delfland Water Authority has set goals to minimise water pollution and close loops for energy, raw materials and water in order to minimise both negative impacts on the (local) environment and (increased) dependency on outside sources. This abstract provides a tool and approach on how to achieve the said goals

Methodology: The opportunity of securing multiple goals, of the water authority and local government units, materialized when the Dutch Ministry of Infrastructure and the Environment made funding available aimed at enhancement of nature and recreational values in the proximity of a related construction project. One of these measures, 'the waterharmonica', showed to contribute to the aforementioned goals. The waterharmonica is an ecologically engineered 'linkage-system' between a Wastewater Treatment Plant (WWTP) and surface water, which aims to improve the water quality in nearby recreational waters. It closes the water loop and removes nutrients, pathogens and revitalizes water in order to be discharged as high quality surface water. However, micro pollutants like medicines, hormone disturbing substances and pesticides are not removed by the waterharmonica and require special polishing techniques at the WWTP. By recycling used drinking water in the local water system, the standstill principle is the starting point and means that the environmental quality of the receiving water body may not worsen.

Findings: In furtherance of achieving the abovementioned goals – decreased dependency on water imports, water quality improvement, close loops and enhancement of recreational and environmental values - transparency and unconditional acceptance of set goals by all stakeholders was needed. Often goals are not transparent and organisations are hesitating to share goals because economic and/or political motives, lack of interest, or the efforts it takes to share and recognize external goals. It has shown that this multi-purpose ecological water system (the waterharmonica) has the potential to bring stakeholders together to combine goals leading to mutual gains.

Significance for practical solutions: The waterharmonica is versatile and could very well align with other goals that relate to sustainable development and climate change adaptation. When politics, problems and solutions come together at the right time, it can create a policy window (Kingdon, 2003). This leads to a momentum increasing the chance of mutually beneficial gains. When all stakeholders are fully aware of this momentum, it can lead to striking solutions for wicket problems.



ABSSUB-781

Water and climate change on average Garonne: adaptation as a bargaining unit

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Research question: Particularly sensitive and vulnerable to climate impacts due to demographic, socioeconomic and environmental issues, the fluvio-estuarine environments are facing significant pressure on water resources: agriculture production, biodiversity protection and development of renewable energy systems (hydro dams). Taking the fluvio-estuary environment of Garonne-Gironde as application area, the French project AdaptEau aims to study the conditions of emerging options of adaptation in the water field to face low water and floods periods through an innovative way using interdisciplinary approach. Through it, AdaptEau uses a co-construction method to reach scenarios on adaptation trajectories involving both researchers and stakeholders by imagining appropriate conditions of water governance at territorial scale.

Methodology: A sociological survey of a sample of 25 selected users and stakeholders from the "Garonne moyenne" territory was carried out in 2013. Semi-structured interviews were conducted with an interview guide elaborated to this purpose, recorded and verbatim transcribed. The qualitative analysis was done using an interpretation grid.

Findings: The results show:

- that water management and governance is taking climate change as a central director principle through different tools and plans, including the participative ways to accommodate the new society requirements;
- that the governance of these strategies of adaptation to global change is taking place at watershed or territorial scale, taking up the challenge to the essential involvement of the main local socioeconomic actors into the decisional process;
- a gap in the interpretation of the observed evolution of the territorial environment by pointing out the responsibility of the local anthropogenic factors rather than the responsibility of climate change;
- that climate change adaptation is used as a bargaining chip tending to reinforce the opposition between three different logics of development of the river area:
 1. quantitative exploitation of water resources for agricultural production
 2. protection of natural environment and biodiversity
 3. using water resources for renewable energy development (hydroelectric dams)
- that "Adaptation" constitutes a response to local territorial changes and evolutions, more than adaptation to climate change.

Significance for practical solutions: Results are pertinent to inform local stakeholders of climate change issues at the fluvio-estuary level. Findings show that there are opposite trajectories in the water development. The social representation of the "climate change adaptation" is still in progress at the local level. Communication, participative meetings with local stakeholders and researchers including role playing games and simulations of case studies are ways to improve the knowledge and assist public decision making.



ABSSUB-1411

The Dutch Delta programme: applying the NEXUS approach for a resource efficient and circular economy

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Research question: Adapting one resource (or policy) may either cause negative consequences in another arena or achieve little change to the system. Due to the web of interconnections, positive or negative impacts to different sectors are possible and often overlooked. Food, energy and water, in the context of climate and socio-economic change, are interconnected, comprising a coherent system (the 'Nexus'), dominated by complexity and feedback. Fresh water is essential for agriculture and food production. Putting pressure on food production (one part of the Nexus) also creates pressures on the other elements of the nexus. What are innovative and transferable approaches among public and private sector involvement, to promote enhanced implementation of the Nexus in practice of the Dutch Delta Programme, supporting a resource-efficient and circular economy?

Methodology: Applying the integrated Nexus approach in the context of the Dutch Delta Programme will deliver a proof of concept, that policies and challenges involving water, food, energy and climate, for a resource-efficient and sustainable economy, can only be addressed in an integrated way. The paper will identify the relevance and policy implications of resource efficiency and circular economy, through a sophisticated analysis of the Nexus of water-energy-food in the context of climate change.

Findings: Although the concept of adaptive management is central to the Delta Programme, the Nexus and the transition to a circular economy are neglected in the process. For an implementation of the Nexus and circular economy more attention should be given to development at firm level and feedback loops at higher scales to follow adaptation paths for different themes of the Nexus. Only recently firms like Uber and Tesla have disrupted to future development of industries, surfing on the waves of energy efficiency and circular economy. These recent developments are a blind spot in the Delta Programme.

Significance for practical solutions: In our opinion more attention should be given to frontrunners in the Nexus and circular economy. The strategy of firms should play a bigger role, reducing the public policy aspects. Uber, Airbnb and Tesla show that technological progress reduces the public domain, increasing the market. As the Delta Programme involves adaptation paths towards the 22nd century, it should encapsulate these innovative firms and more focus on the firm level. We focus on freshwater supply. Measures to improve freshwater supply involve joint responsibility on the part of the central government, the region and consumers including business. The development to the Nexus and circular economy will lead to a substitution of scarce water for new technologies. An incentive strategy for this development will reduce the freshwater demand, if water really becomes scarce.



ABSSUB-1317

Evaluation of small scale water harvesting techniques for water supply in semi-arid environments

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Research question: How do different types of water harvesting systems perform in terms of supplying additional water and costs related to construction and maintenance?

Methodology: We review the peer reviewed literature to identify the characteristics that determine the success of water harvesting techniques in least developed countries. In addition, we assemble a database containing values for these characteristics, using information gained from the literature and from reports of international organisations (e.g. ILRI, FAO, etc.). We use the database to: 1) Analyse which techniques are suitable for meeting domestic, livestock, or agricultural water demands; and 2) Quantify the requirements and benefits of the water harvesting techniques. For techniques improving water availability for domestic use and livestock, we also compare the results with information from implementing organisations such as NGOs and funding agencies that frequently apply and evaluate small-scale water harvesting techniques. We then propose a decision framework to support people and organisations involved in implementing water harvesting projects in choosing appropriate techniques.

Findings: Our research reveals that the information required to evaluate the sustainability and applicability of individual water harvesting techniques is lacking in many settings. Better public access to this information would promote better design, evaluation, and selection of water harvesting projects in the future. On the basis of the available information, we conclude that larger water harvesting structures have lower costs per unit of water captured. When accounting for the lifetime of the structure, the unit costs range from US\$ 1 per m³ to US\$ 9 per m³ for small structures (<500m³), and from US\$ 0.04 per m³ to US\$ 0.40 per m³ for larger structures (500–5000m³). For smaller structures, less technical knowledge is needed, the initial investment cost is smaller, and the governance is less complex than in the case of larger structures. Water harvesting is a suitable strategy for adapting to water shortages caused by climate change.

Significance for practical solutions: Water harvesting is a suitable strategy for adapting to water shortages caused by climate change. Agencies and donors wishing to advance agricultural development must consider local circumstances and indicators of social and economic conditions when evaluating alternative investments. The information presented in the paper can assist them and other practitioners in focussing on pertinent characteristics. Such an approach will ensure that water harvesting projects are not considered in isolation, but as part of the integrated social, cultural, economic and physical system.



ABSSUB-925

Climate adaptation to water scarcity in glacier-dependent city of the Indian Himalayas

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Research question: Among the current and expected impacts of climate change, impacts on water resources are expected to intensify the present and future threat of worldwide water scarcity. Societies of Glacier dependent are especially vulnerable to water scarcity due to the more noticeable effects of climate change on glacial systems that oversee the water availability of these societies. In this research paper, water scarcity is examined as an impact of climate change in the glacier-dependent city of northern India, while recognizing that climate change is not the only factor causing reduction of water resources in this city.

Methodology: In order to understand the impacts of climate change on water resources of glacier-dependent city at the ground level, fieldwork was conducted in the city. This case study in India was selected on the basis of a preliminary literature review, press articles highlighting the extent of water scarcity in these towns, and phone interviews with specific organisations in the towns, which confirmed the salience of water scarcity issues at the ground level.

Findings: In order to show the linkage between climate change and water scarcity, evidence is presented on changes occurring in the city local climate parameters such as snowfall, rainfall and temperature, as well as changes in the hydrology of the water bodies that make water available to this city. This establishes that water scarcity in city has been brought not only by growing demand, but also by diminishing supply of water. Furthermore, climate change considerations have been largely absent in the policy/planning processes that administer water management in the city. Continuation of unsustainable economic development in the city coupled with failure to explanation for climate change impacts in water management opinions to the presence of numerous technological, infrastructural, financial and political barriers to the planning/implementation of inclusive climate centric strategies for adaptation to water scarcity in the city.

Significance for practical solutions: Based on the study and findings, recommendations are offered to enable the local governments of the city to overcome these obstacles.

ABSSUB-1112

Water Quality Index for Irrigation of Cropping Area using MODIS Sensors' based MOD13Q1-NDVI Data

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Research question: Groundwater quality has the reflective outcome on crop yield potential in semi-arid zones. Water quality index has an ultimate goal for obtaining maximum production per unit of available water supply along with significance for remedy of domestic, industrial and irrigation water supply. Natural water body's response environmental conditions that have been studied by scientists for identifying sources and fates of contaminates. Water Quality Information Center provides electronic access to information on water



quality and agriculture. Geospatial technology plays a vital role in geospatial data acquisition of the water quality index at local, regional, and global scale. The advantage of Remote Sensing and GIS is that it helps in getting wide area observation, periodical and continuous measurement, and availability of digital data processing standardization. This study focuses on assessing the water quality for irrigation practices.

Methodology: The data of IRS P6 LISS III (September 2012) was used in GIS frame. Geospatial technology helps in getting the spatial distribution of chemical parameters using inverse-distance weighted and modified Shepard's method for spatial interpolation.

Findings: This research paper illustrate statistical multiplication of water quality in terms of suitability index using pH, total dissolve solid, total hardness, alkalinity, sodium, chloride, nitrate, electric conductivity, and express the impact of water quality on regional crop yield. Higher water quality index depicts the best appropriateness for irrigation practices.

Significance for practical solutions: This conference contains various committees, chaired by eminent persons. The conference would be ultimate exposure of knowledge and interaction among different countries brainstorm. It will be nice experience for me to see the applicative approach of different remote sensing techniques for the social improvement and new geospatial activities of different people gave new and innovative ideas to do some pioneering in this field. This conference would be a common platform for all the researchers, scientists and students which helped in sharing knowledge among different people from different areas. Presenting my paper at this conference would give me a unique opportunity to interact with co-researchers from different parts of the world working in the area of gas turbines. The technical inputs and/or suggestions that I receive during the oral presentation and discussions with authoritative personalities would be of great help for my research work.

ABSSUB-1276

Studies on iron pollution in ground water samples of Dandakaranya Area, Chhattisgarh State, India

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Research question: Monitoring studies on iron pollution were carried out on ground water samples ($n = 130$) from Dandakaranya area (Bastar), the largest forest cover area of Chhattisgarh State [19N05 82E04] Central India. The same area is also well known mining belt for iron ore. The ground water is mostly used by the tribal population in the study area.

Methodology: The ground water samples were collected in the pre-monsoon and post-monsoon seasons following the standard procedures of APHA and AWWA. In this work iron concentration was determined by using the flow injection analysis method based on the measurement of the red pink colour of Fe(III)-SCN^- - $\text{CP}^+_{n}\text{BP}^+_{y}$ quaternary complex at an absorption maximum at 495 nm.

Findings: The iron concentration in the ground water samples was found in the range of 0.025 – 600 ppm ($\mu\text{g ml}^{-1}$) which was found to be much higher than the permissible limit of 0.300 $\mu\text{g ml}^{-1}$. The ground water of the polluted area was found to be generally colourless but became opalescent when it came in contact with air and finally useless for the domestic purposes. The opalescence is due to the oxidation of Fe^{2+} to Fe^{3+} and their subsequent hydrolysis into hydrated oxides. The iron in reduced form was found to be more dominant in the



ground water samples than the surface water of the study area, and the ratio of $\text{Fe}^{2+}/\text{Fe}^{3+}$ was found to be in the range of 1.5 to 2200.

Significance for practical solutions: The results of the present work shows that prolong and chronic excessive use of contaminated water for the drinking purpose may affect the health of the population in the study area. These results may also be useful for creating a data base in relation with a warning signal for the use of water samples for domestic especially potable purpose. At the same time there is a need for regular monitoring of water quality including iron contamination that will help to alarm the residents of the study area.



ABSSUB-1336

Impact of climate change on vulnerable medicinal plants

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Research question: Is Vulnerability of climate change has an impact on medicinal plant?

Methodology: Prioritizing medicinal plant confined to shola forest region of the western ghats, and identification of medicinal plants confined to shola forest region and tend in the climate and rainfall and other anthropogenic sources were analysed in the study.

Findings: The Nilgiri Hills, an integral part of the Western Ghats of peninsular India, is located between 11° 10' - 10° 30' N and 76° 25' -77° 00' E . The altitude in the upper areas of the Nilgiris range from 1800 to 2600 m asl. April is the warmest month with a mean maximum temperature of 25 °C, and January is the coolest month with a mean maximum temperature of 5 °C. Frost occurs at night on several days from November to March. The Nilgiris experiences two wet periods; the first receiving rain from the southwest monsoon between June and September, and the second from the northeast monsoon between October and December. The rainfall in the western regions of the plateau ranges from approximately 2500 mm to 5100 mm. The Nilgiris being one of the first biosphere reserve of India, lies in Western Ghats of peninsular India. It has a unique bio-geographic region with many endemic medicinal floral and faunal species covering three states i.e. Tamil Nadu, Kerala and Karanataka. Entire area is having countless micro flora, fauna and the germplasm bank of various rare, threatened and endemic species and are facing continuous pressure by one way or the other. The landuse and land cover changes has been observed in the study area which also has caused stress on this medicinal plants. A majority of the Nilgiris landscape, originally under native grass cover, has been urbanised, farmed, submerged by large reservoirs, or converted to commercial plantations of tea and exotic trees, viz., Black wattle (*Acacia mearnsii* De Wild.), Blue gum (*Eucalyptus globulus* Labill.) and pine (*Pinus patula* Schltld. & Cham.) (Srinivasan et al., 2015). The high altitude areas of the Western Ghats are like virtual islands, isolated from neighboring ranges by lower altitude and plains areas where physical, biological and human issues are very different. It has led to a unique assemblage of biodiversity in each of these islands. The average annual rainfall of this reserve ranges from 500 to 7000 mm. In the current study Identification of prioritized endemic species confined only to shola regions is the one of the critical aspect in identifying ecotone species in the study area, as this plants due to climatic stress cannot be grown or propagated in other regions, the survival rate is less. The climate trend analysis for past 30 years and future climate data shows that there is increase in temperature and reduction in rainfall, deforestation and frequent forest fires pose threat to existence of these endemic medicinal species.



ABSSUB-564

Projection of rural and urban human thermal comfort in the Netherlands for 2050: a methodology

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Research question: This study investigates the research questions:

- Can we develop a methodology to quantify future human thermal comfort?
- By how much will the abundance of adverse human thermal comfort increase in 2050 in The Netherlands?
- Can the trend in adverse human thermal comfort be moderated by urban design, using aspect ratio and urban vegetation as tools?

Methodology: This study analyses the future human thermal comfort for both coastal and inland Dutch cities and countryside. The future conditions are based on the KNMI-O6 climate scenarios. Using these scenarios, observed weather data from 1976-2005 are transformed to future weather design data representative for 2050. Subsequently, human thermal comfort expressed in the Physiological Equivalent Temperature (PET) is estimated for these future scenarios.

Findings: A substantial increase of heat stress abundance is foreseen in all climate scenarios, for both urban and rural areas, particularly under the most intense warming. In these scenarios, *the frequency of hours with heat stress more than double*, and the increase will develop faster in an urban canyon than in rural areas. In urban areas PET shows a maximum as function sky-view factor, i.e. for a smaller sky-view factor a wind speed reduction increases the PET on one hand, and shading reduces the PET on the other hand.

Significance for practical solutions: Heat stress is a leading cause of weather-related human mortality and morbidity, and reduced labour productivity. As temperatures are projected to increase due to climate change, the human thermal comfort is expected to worsen. In The Netherlands, the excess mortality can rise to 12% during heat waves, corresponding to about 30 additional deaths per day and per Kelvin above the climatological mean temperature. Here, we quantify the current and future human thermal comfort in the Netherlands that practitioners can use as benchmark in their work. Also, the impact of interventions in urban design on thermal comfort are quantified.

ABSSUB-1484

Standing the heat during the 2013 heatwaves in the Dutch province of Limburg

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Research question: Within The Netherlands, very little is known about the morbidity impacts of and heat protection behavior during heat waves. The HEAL (Health Effects of heAtwaves in Limburg) project explores health impacts and heat-related behavior during the 2013 heatwaves (July 21-17; August 1-5) in the Dutch province of Limburg.

Methodology: The online HEAL questionnaire was completed by 588 adults and surveyed self-reported heat-related health outcomes, heat-protection measures and risk perception (in view of climate change).



Findings: Our results show that 35% of the respondents felt severely hindered by the extreme heat; for the elderly (65+ years) and for chronically ill persons this number was 43%. About 35% of the participants reported to have suffered (to a moderate or high degree) from sleep deprivation/disturbance; 13.4% reported that they had even felt exhausted. Results also revealed that 3.4% suffered from heart problems and 9.7% from respiratory problems (4.8% respectively 11.1% in the elderly) during the heat events. Other reported health outcomes included problems concentrating (16.8%), swollen legs, hands or feet (14.3%), feeling irritated (12.7%), dizziness (8.0%), headache (9.7%), and skin irritation (8.7%). The majority of respondents attributed the onset or aggravation of their symptoms to the high temperatures. Furthermore, respondents reported to take (frequent to very frequent) heat-protection measures, in particular drinking regularly (94%), wearing appropriate clothing (93%), and opening windows at night (91%). Other measures included taking a cool shower/bath (58%), staying inside (60%), avoiding strenuous activity (65%), and using sun-blinds (78%), fans (49%) and air-conditioning (19%). The elderly were more likely to stay inside and avoid activity, while the younger participants were more likely to use air-conditioning. Three-quarters of the respondents did not know about the National Heatwave Plan; however, 89% indicated to be (reasonably) well-informed about possible heat-protection measures (mostly via television and internet). Almost one-quarter of the respondents indicated to be (somewhat to very much) worried about the impact of a future heatwave on their health; this proportion was almost one-third in the elderly and in the chronically ill. More than two-thirds believed that it is (very) likely that heatwaves will become more frequent due to climate change; about 63% thought that more frequent/intense heatwaves will lead to health impacts within the population.

Significance for practical solutions: Our study has found a relative high level of awareness of the actions to take during heatwaves. However, the stratified analyses of relevant sub-groups (e.g. elderly, low income, chronically ill) can contribute to identifying opportunities for additional/targeted information, in particular in view of the increasing concern about heat-related health impacts of climate change.



ABSSUB-752

Ecosystem-based adaptation approaches as an integral component of sustainable groundwater management

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Research question: Can ecosystem-based adaptation be used as an integral component of sustainable groundwater management?

Methodology: Ecosystems provide services that contribute to human livelihood. While the importance of ecosystem services is recognized, their existence is often taken for granted by their users. Groundwater plays an integral role in sustaining certain types of ecosystems, and their associated services. After consultation with experts, we present an overview of adaptation approaches that integrate groundwater management and ecosystem services.

Findings: Groundwater recharge zones affect both the quantity and quality of water reaching aquifers. Recharge zones are therefore at the centre of preventing pollution and maintaining supply for groundwater dependent ecosystems (GDEs). Currently, protection of groundwater recharge zones is primarily used in drinking water supply areas. Such protection schemes could be expanded to include ecosystems in critical groundwater recharge areas to improve their resilience and secure their services. The hydrological connection and fluxes from recharge areas to GDEs are of vital importance to sustain GDEs. Understanding the regional hydrogeology and the level of groundwater dependency of these ecosystems can help to support decisions about prioritization of adaptation measures.

Riparian zones are efficient in water quality improvement for both surface runoff and water flowing into and out of streams through subsurface or groundwater flow. The services of riparian zones should be better integrated with land use planning.

The soil plays a significant role in any groundwater protection strategy. Good soil management can support protection of groundwater resources. Prevention of soil erosion is one way to improve groundwater quality. Critical zones can be indicated where Ecosystem-based Adaptation approaches will be most beneficial. Because the hydrological system is interconnected on various levels, adaptation measures in these (local) critical zones can be used strategically for groundwater management on a larger, regional scale.

Significance for practical solutions: Investing in natural infrastructure can reduce costs and enhance water services and security. Measures to ameliorate the natural drainage system and increase groundwater storage include preservation of wetlands and lakes. Also the construction of artificial wetlands, basins, ponds and re-meandering, could emulate the positive services and contribute to improved groundwater recharge and groundwater quality. Ecosystem-based adaptation approaches can support cost-effective adaptation against threats that result from multiple pressures. Protection and preservation of natural infrastructure does not replace the need for built infrastructure, but instead provides a complement multiplying the benefits received from healthy, functioning ecosystems.



ABSSUB-645

Development of climate change risk assessment and delivery of adaptation in the natural environment

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Research question: What lessons can be drawn from the development of climate change risk assessment and delivery of adaptation action in the natural environment sector in the UK?

Methodology: Ecosystems and the services they provide are threatened by a range of pressures compounded by population growth and climate change. In the UK, the threat of changing temperatures and rainfall patterns on biodiversity and ecosystem services has been recognised in the national Climate Change Risk Assessment (CCRA), published by the UK Government in 2012. The CCRA suggests that the “direct and indirect impacts of climate change on the natural environment could be significant by the 2050s, potentially further exacerbating existing pressures on ecosystems and contributing to the further decline of some species” (HM Government 2012). Over the last 15 years a significant body of work identifying the vulnerability of the natural environment in the UK to the impacts of climate change has been built up. Alongside the development of climate change risk assessment, much has been learnt over the past 15 years about the adaptation actions that are necessary to improve the resilience of the natural environment to climate change (and other pressures); the response has been an evolution in our thinking, starting with the identification of high-level adaptation principles for biodiversity (e.g. England Biodiversity Strategy Climate Change Adaptation principles) with the focus now on delivery of ecosystem based adaptation at a range of spatial and temporal scales (e.g. Natural England Climate Change Adaptation Manual).

Findings: This paper explores development of this work from the early focus on species-based risk assessments driven by detailed bio-climatic data (e.g. Modelling Natural Resource Responses to Climate Change (MONARCH)) through to vulnerability led approaches that have considered adaptive capacity and ecosystem/ecosystem service resilience (e.g. Natural England National Character Area climate change vulnerability assessments). This paper will draw upon Atkins' work with Natural England (the UK Government adviser for the natural environment in England) into adaptation at a range of spatial/temporal scales, covering landscape, reserve and field scale actions.

Significance for practical solutions: Drawing on a range of examples from the UK the paper will offer insights for practitioners undertaking vulnerability assessments of ecosystems and ecosystem services. Findings from a range of projects will be summarised and lessons learnt presented in order to inform the planning and delivery of actions on the ground, linking across a range of scales.



ABSSUB-1268

Exploring benefits and co-benefits of ecosystem-based approaches to support urban adaptation

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Research question: Ecosystem-based approaches to adaptation (EBA) have been recently promoted as a useful approach to reduce the adverse impacts of climate change while providing broad range of nature's benefits, such as water retention, reduction of flood risk and air pollution, cooling during hot season, recreation, etc. Ecosystem-based approaches can play a significant role in societal adaptation to climate change and may increase resilience. This study is part of UrbanAdapt project that aims to initiate and further develop the process of preparation urban adaptation strategies in the pilot areas of three large cities in the Czech Republic - Prague, Brno and Pilsen. In order to support decision-making and development of urban adaptation strategies, we aim to provide an overview of a broad range of benefits and co-benefits that ecosystem-based approaches brought to the society.

Methodology: To promote the use of ecosystem-based approaches in urban adaptation, we have applied the adaptation cycle as a generic framework to adaptation planning. First, we assessed climate related risks and impacts experienced in cities in the present and for the future state (in 2030). To ensure effective participation of stakeholders, we organised a series of participatory workshops where risks as well as adaptation measures have been rated. Various ecosystem-based adaptation measures have been prioritized by stakeholders using multiple criteria (including economic aspects, timeframe, etc.) and main barriers as well as opportunities for implementation have been identified using findings of an institutional analysis. The results of the participatory workshops indicate that most of the EBA measures have a very high priority among stakeholders.

Furthermore, the adaptation decision cycle was complemented by systematic literature search on biophysical benefits and co-benefits of various types of EBA measures.

Findings: In our study, we provide evidence on the biophysical and economic effectiveness of various ecosystem-based adaptation measures such as green roofs, green walls, urban parks, green and blue infrastructure, river restoration, sustainable drainage systems, rainwater harvesting, etc. Combined with the results of the multicriteria analysis, we identified site specific ecosystem based solutions for mitigating the risks of climate change for each of the pilot cities.

Significance for practical solutions: Outcomes of this study contribute with relevant findings to support decision-making in the area of climate change, adaptation strategies development as well as urban planning.



ABSSUB-220

Framing climate adaptation in nature conservation: stakeholder perspectives in dutch brook valleys

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Research question: 1) how do decision-makers and stakeholders frame the issue of adapting nature conservation to a changing climate in terms of problems and solutions?; 2) what are the main similarities and differences of these climate adaptation frames?; 3) what do the similarities and differences of these frames imply for a successful adaptation strategy?

Methodology: We investigated the framing of climate adaptation of nature conservation by different actor groups in two brook valley catchments in The Netherlands – the Baakse Beek and the Tungelroyse Beek. Brook valley ecosystems are very sensitive to climate change due to their dependence on specific ground- and surface water regimes and the expected increase in both winter floods and summer droughts. Frames were identified using the framework developed by Entman (1993), which distinguishes between 'problem frames' (what is the problem, why and for whom?) and 'solution frames' (who should do what?) of actors involved. Consequences were determined in terms of substance (what climate change impacts are focused on, which aspects are ignored?), and prospects for collaborative action (by assessing the sense of urgency for climate adaptation and overlap or differences in frames).

Findings: The dominant frame defines climate adaptation as a matter of managing increasing risks of drought and flooding. No or less attention is paid to soil, water quality and forest fire risks. Actors involved (regional authorities (provinces and water boards), nature conservationists, farmers, private land owners) perceive climate change adaptation at the level of the brook valley catchment water system, not at the level of specific species affected by climate change. Water containment and temporary water storage are therefore widely supported to abate water quantity problems and water boards are put forward to take a leading role in multifunctional regional adaptation. The main differences in frames concern the nature and scale of preferred adaptation measures and the expected negative consequences of climate adaptation measures in one sector on other sectors. The debate about and selection of specific adaptation measures (in particular related to water management) will form a key challenge in the development and implementation of adaptation plans. The one-sided attention being paid to water quantity issues on the one hand offers some common ground which facilitates a collaborative adaptation planning, but on the other hand poses a risk because not all climate impacts on nature conservation are acknowledged.

Significance for practical solutions: Climate change adaptation, in particular at the regional level, typically is a multi-actor and multi-sector governance challenge, which requires adaptation measures that serve multiple objectives, and collaborative action. A framing analysis such as the one we outline in our paper is a first step in the search for common ground in the problem analysis and exploration of alternative adaptation measures, both in terms of substance and in terms of organisation.





ABSSUB-438

Linking plant diversity and soil properties to the climatic resilience of farmland riparian buffer

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Research question: Riparian forests of agricultural landscapes are protected for several reasons including biodiversity conservation, bank stabilization and improvement in water quality. Despite this, the benefits of preserving the underlying soil properties and functions remain poorly understood. In this study, two related questions are answered: (1) Do riparian forest buffers on farmlands able to maintain soil properties similar to that found in protected area? (2) Are there significant relationships between farmland riparian plant diversity and soil properties?

Methodology: The study was conducted along Afram river in protected area (PA) and farmland (FA) in the Guinean savanna zone of Ghana. ALOS-AVNIR imagery was used to map the riparian buffer in the catchment of the study area at accuracy of 89% to facilitate stratified randomized sampling. Thirty six randomly selected plots (each 500m²) equally divided between the PA and FA within a buffer zone of 50m were used for the inventory of woody species having diameter at breast height ≥ 5 cm. Soil samples were collected to a total depth of 40cm in each plot for the laboratory analysis of physical (texture and bulk density) and chemical (Carbon (C), Nitrogen (N), Phosphorus (P), Potassium (K), pH) properties. T-test was used to estimate the significance of the differences in the woody plant diversity, density and soil properties between PA and FA. Simple linear regression analyses were used to establish the relationships between the diversity and density of woody species and soil properties on farmlands.

Findings: The riparian soils in both PA and FA were described as sandy loam. Although t-test showed that the diversity and density of woody plants were lower in FA compared to PA, there were no significant differences in the means of C, N, P, K, pH and bulk density between the PA and FA. Of the soil attributes measured, the regression analyses showed that only C and C/N ratio had significant positive relationships with the diversity and density of woody plants in the farmland.

Significance for practical solutions: The findings of the study suggest that the farmland riparian buffer of the Afram river have been effective in preserving the underlying soil properties to conditions similar to that found in protected area. Nevertheless, any further degradation of the farmland riparian forests could trigger soil erosion and flooding to result in the loss of soil nutrients and structure. This would have negative consequences on the aquatic ecosystem including pollution and sedimentation. Based on the findings, there is a need for enforcement of the Ghanaian freshwater management policy in the Afram river and other riparian basins to ensure that farming is excluded in buffer zones. Farmers should also be discouraged from intensive extraction of resources such as fuelwood and non-timber products. This would protect the riparian habitats to sustain its functions such as nutrient buffers, particle filters and carbon sink.



ABSSUB-472

Adaptation tipping points of urban wetlands under climate change and urbanisation

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Research question: Wetlands have been the focus of conflicting priorities in a social-economical context. Their loss as a result of increasing water demand, land-use changes and climate change have contributed to significant alteration of their hydrology. Several studies were undertaken to apply the concept of adaptation tipping points to examine water management strategies under different climate scenarios and to determine how long baseline strategies will be effective. Most studies were conducted in the European context of flood risk management and investigated which structural engineered measures could be taken to postpone or eliminate the point where a baseline strategy no longer meets its objectives. Tipping point analyses applied to ecosystems are limited. Little progress has been made to identify the interacting effects of drivers on the biophysical system at an appropriate scale. This will be the first study to focus on identifying tipping points for a biophysical system and to investigate which objectives are critical to meet to prevent wetland management strategies from failing. This paper examines the potential environmental impacts by 2030, 2050 and 2080 of urban wetlands in a rapidly urbanising catchment area with shallow groundwater level under a future drying climate in Perth, Western Australia.

The questions that will be answered are when tipping points in the biophysical system occur and which objectives are critical to deliver its ecological objectives.

Methodology: The adaptation tipping point methodology was applied to determine the main driver and objectives of the groundwater and wetland management strategies. A coupled groundwater-surface water model (MIKE-SHE) was used to determine future groundwater levels. One historical and three future climate scenarios were modelled and analysed to determine whether objectives for maintaining minimum and maximum groundwater levels in the ecosystem were compromised.

Findings: These scenarios showed a continuous decline of groundwater and surface water levels in the wetlands. Critical minimum water levels to sustain birds, groundwater dependent vegetation, and invertebrates were found to be more frequently compromised. By contrast, groundwater levels were more frequently below the maximum which resulted in more flood resilience due to overcapacity of existing drainage infrastructure. Despite increasing urbanisation and consequently increased recharge, it is likely that the wetlands continue to dry in the future.

Significance for practical solutions: The significance of climate change impacts to the hydrological regime and the consequences to ecological objectives of such change could inform stakeholders about what local adaptation measures to take and when to postpone or eliminate these tipping points. The aim of adaptation is to provide timing of (non)-structural measures to maintain ecological and water engineering objectives. This research could provide an understanding of changes of biophysical systems that are currently under pressure by climate change.



ABSSUB-519

Climate change impact assessment on natural forests in Japan and adaptation measures

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Research question: It has been reported that climate change will modify ecosystems. Natural forests are dominated by many canopy tree species and their geographical shifts possibly cause major changes in biodiversity and ecosystem functions. However, information of future range changes of major forest species are limited in East Asia. In this study we forecasted future potential habitat changes of major forest canopy tree species in Japan and investigated possible adaptation measures at a national scale.

Methodology: For the forecast of future habitat changes on tree species distributions, we adopted species distribution models for each target species. Target species were stone pine (*Pinus pumila*), silver fir (*Abies veitchii*), beech (*Fagus crenata*) and evergreen oak (*Quercus acuta*). Each one of them is representative species from different forest zones (alpine, sub-alpine, cool-temperate and warm-temperate zones). Spatial resolution was set at c. 1 km². Presence/absence records of each species were extracted from published and original phytosociological relevant data sets. Four climatic factors were used as predictor variables. They are the warmth index of Kira (WI), minimum temperature of the coldest month (MT), summer precipitation (PS) and winter precipitation (PW). Three RCP (2.6, 4.5, 8.5) with four GCMs (MIROC5, MRI-CGCM3, GFDL-CM3, HADGEM2-ES) were used for the future climate.

Findings: With respect to four dominant tree species in each of the four climate zones, stone pine and sub-alpine fir were projected to decrease their potential habitats greatly. Stone pine was projected to decrease to between 0.9% and 16%, depending on RCPs. Sub-alpine fir was again projected to decrease to between 9.9% and 69%. Cool-temperate beech was projected to either increase or decrease, depending on the RCPs between 25% and 116%. Warm-temperate oak was projected to always increase to between 108 % and 119%. However, expansion of evergreen oak can be expected to be limited because the migration of the species is slow and natural forests where it is found are fragmented.

Significance for practical solutions: Populations of beech decline when they are logged, because regeneration speed is relatively slower than other tree species. Thus, nature reserves where logging is avoided, should contribute to beech conservation and climate change adaptation. According to a geographical comparison of potential habitats of beech and nature reserves in Japan, the areas of potential habitats located within nature reserves was 22,122 km² under the current climate, but it was projected to decrease between 17,597 and 4,525 km². However, the area of potential habitats located outside of the nature reserves was still sufficient. Therefore, converting parts of these habitats into nature reserves is one of the adaptation measures for conservation of beech in Japan.





ABSSUB-1232

Social network maps for understanding community preparedness and response: an Alpine case study

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Research question: Social networks play an important role when preparing for, responding to and recovering from natural hazards. Social network mapping approaches can help to better understand and visualize relationships between different type of actors or communities across levels of governance and scales. Created maps can a) help to increase people's preparedness, b) contribute to the effectiveness of response and recovery measures by identifying barriers and gaps in coordination and communication among actors and c) trigger a critical reflection about existing risk management practices. We will present the work and results from a case study in Badia, Italy, a small alpine municipality that recently experienced a landslide event. Our study looked at two types of communities: the geographical community composed by all persons living in Badia, and the community of supporters composed by individuals, organisations and authorities that provide risk management services. We wanted to investigate existing network structures within the communities looking at whom, in case of an emergency, people contact from their personal network as well as which organisational or institutional actors. Additionally, we were interested how different kind of experts, actors, organisations and authorities operating at different levels of governance worked together, shared information and collaborated during the response and recovery phase. Finally, we looked at the horizontal and vertical ties and interactions between the networks.

Methodology: Within the study, we applied a mixed method approach. Through a population survey, we collected data about the relationship between individuals and risk management organisation. The visualisation of this data in a social network map allowed us to identify who the key actors are, according to the people living in Badia and which actors tend to be contacted together in case of emergencies. During interviews with the identified actors, the maps were discussed and validated in terms of coherence with what is foreseen by local emergency plans. Subsequently, a participatory social network mapping exercise was carried out to visualise patterns of responsibility and the relationship of the different authorities and actors involved and responsible for natural hazard management.

Findings: Our results show the importance of a) persons belonging to both types of communities and acting as linking node - having vertical relationships between them, b) mutual trust among network members c) maps as a tool for structuring and visualising the knowledge of a range of significant actors.

Significance for practical solutions: The use of participatory approaches allowed us to discuss and figure out how these results can be applied and integrated local and regional strategies for risk management. In conclusion, we will show how part of our findings can support climate change adaptation and be transferred to other contexts.



ABSSUB-640

ECOSYSTEMS BASED ADAPTATIONS OF CLIMATE CHANGE ON THE WESTERN SLOPES OF MT KENYA FOREST ECOSYSTEMS.

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Research question: Ecosystems enhance natural resilience to the adverse impacts of climate change and reduce the vulnerability of the rural people. A well-functioning ecosystem is critical for both human and animal life. Mount Kenya ecosystem provides many benefits to communities living within and around it and as well maintain and enhance ecosystem services and biodiversity conservation. Ecosystem-based adaptation offers a valuable yet under-utilized approach to impacts of climate change.

Methodology: The study was carried out in the Western slopes of Mount Kenya forest ecosystem with the aim of evaluating the impacts of climate change on the community livelihoods and further provides the best adaptations strategies. A semi structured questionnaire enriched by field observations were used to collect data. A cross sectional transect of 10km along the ecosystem was selected whereby 100 households were sampled. Purposive sampling was used to get in depth interview from key informants and at household level. Document analysis was used to examine hydro climatic data of the area for the last 30 years.

Findings: The study revealed that the variability in rainfall and temperature affected the stream flow and volumes and thus the water available for household consumption, for rain fed cropping and for irrigation (in the downstream zones where rainfall was supplemented by irrigation during the more dry months). These scenarios had direct impacts on community livelihoods in terms of food production and livestock density. From the study there was a positive correlation between rainfall and stream flow volumes. This often led to food insecurity and water user conflicts. To adapt with the adverse effects on climate change of the Mountain ecosystem the community preferred livelihood diversification and sustainable land use technologies.

Significance for practical solutions: The study recommends community awareness of the strategies to cope with changing climate and alternative opportunities and services available from these ecosystems. These may include establishment of diverse agroforestry systems, management of river line system and conflict resolutions among the waters users.



ABSSUB-357

Disaster risk management and financial supervision

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Research question: Natural disasters and economic crisis affect our personal wealth, the prosperity and stability of nations and eventually demand international cooperation to master their impacts. The channels via which initial effects propagate through the economic and societal system diverge considerably. The underlying idea behind the measures available to alleviate eventual impacts, however, is rather similar. In financial supervision one of the main objectives is to ex ante minimise potential adverse impacts. If a disastrous event happens nevertheless, predetermined action plans must be in place to guarantee a swift and smooth transition. The same logic applies to climate change adaptation and disaster risk management; Enhance the resilience by implementing suitable adaptation measures and develop contingency plans for events were adaptation measures are insufficient. Based on this similarity it is interesting to see to what extent instruments applied in financial supervision can be adapted to the field of climate change adaptation and disaster risk management.

Methodology: This article is of conceptual nature. First measures and instruments applied in financial supervision are reviewed and assessed regarding their applicability to the field of disaster risk management. It is found that the *three pillar approach* followed in financial supervision is a promising way to be followed in climate change adaptation and disaster risk management. Then, the combination of quantitative and qualitative requirements and guidelines regarding market discipline for the banking and insurance system are adapted to fit the needs of municipalities and cities.

Findings: It is found that the financial supervision literature provides promising instruments and measures, which are transferable to the field of climate change adaptation and disaster risk management. The quantitative requirements contain provisions for enhanced risk coverage and limited exposure concentration. Transferred to municipalities these provisions can be implemented via value at risk calculations based on weather variables and the existing building stock, as well as zoning regulations to steer settlement development. Within the scope of qualitative requirements, own risk and solvency assessments as well as continuous risk management and supervision are suitable means to regularly assess potential extreme event and disaster risk and ascertain that capital demands in case of disaster are covered

Significance for practical solutions: Building on the layered disaster risk management approach introduced by Mechler et al. (2014), the study takes a closer look to the low to medium risk layers for which risk reduction and risk financing are the most promising ways to increase the resilience against extreme weather events and natural disasters. Thereby it provides a practical insight into existing measures and instruments, which incentive risk reduction and increased resilience and studies its potential implementation within climate change adaptation and disaster risk management.



ABSSUB-335

Live at sea as an adaptive solution: a pattern language for floating cities

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Research question: The act of living at sea permanently is being proposed as an adaptation measure to the risks associated to the climate changes, mainly the ones related to water management, like raising of the sea level and floods. Prevention measures as protection barriers, even if calculated with predictions of more than 100 years, can suffer with extreme events, like giant waves, hurricanes and tornados, being damaged and breaking. Meanwhile a city at the sea would be able to follow ocean movements and even sail to other regions, if a huge event were predicted. Based on the above, the hypothesis raised is that if a city at sea had been built, it would have different building techniques, politics, legal, economics, social, biological and urban characteristics, distinct of a city in the continent.

Methodology: The methodological procedure to determine the characteristics of a floating city consisted of two stages: maritime occupations (existing places) and floating cities projects (imaginary proposals) analysis, and the construction of pattern languages to each object, based on Christopher Alexander methodology (1977). The comparison between the two languages made possible to obtain the characteristics of a floating city.

Findings: Maritime occupations language is made of 53 patterns and 56 sub patterns, grouped in 13 categories, while the language of urban projects presents 66 patterns and 22 sub patterns grouped in 16 categories. The commons patterns are found, mostly, in technical constructive terms, bringing the floating city closer to a vessel; meanwhile the different patterns expose the attributes that a urban settlement requires, like production, urban fabric and growth.

It was identified that by being in the sea, the patterns of a floating city configure distinct shapes of a land city. We can identify the weight distribution, symmetry, the definition of needs agreeing with the seakeeping and habitability, the enrolment in the maritime authority and the presence of technical officers, like in others maritime settlements. A relevant point to the comprehension of floating cities refers to the mobility, because the city soil has to be built, resulting in a series of opportunities like the total displacement of its base or separated parts, its placement in the high seas with possibilities of self-government; and flotation, following the sea level.

Significance for practical solutions: This research had as main goal to contribute to urban discussion in limit or non-conventional environments. The study of urban conformation at sea allows to explore conditions that are not performed yet, opening a new field of discussion about the reproduction of urban elements, the social conditions of its inhabitants and the legal means to its effectuation. That said, the research becomes an important theoretical instrument to the discussion about building floating cities, taking in account that the subject is being highlighted, mainly in countries that suffer with the raising of the sea level.



ABSSUB-1201

Unfolding differential livelihood vulnerability for disaster resilience in Indian sundarbans

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Research question:

- (i) Why livelihoods of coastal people are more vulnerable than the non-coastal people?
- (ii) What are the factors responsible for making livelihood of people living Below Poverty Line are more vulnerable than the people living Above Poverty Line irrespective of geographical settings?
- (iii) Do responsibilities on the basis of gender i.e. female headed households vs. male headed households' leads to differential livelihood vulnerability?
- (iv) Which are the groups that emerged out of 16 combinations of geographical settings, economic conditions and social background are the most and least livelihood vulnerability to climate related disasters and why?
- (v) What are the best measures required for making livelihoods disaster resilient for all the selected 16 groups?

Methodology: Three coastal villages and three non-coastal villages were selected randomly from very high vulnerable blocks of the area. 180 households were selected giving representation to physical, economic and social aspects of households. The household data was collected based on structured questionnaire for making comparison between strata of households existing within physical, economic and social categories about the livelihood vulnerability. There are five capitals divided into 14 components and 33 indicators which were used for construction of Livelihood Vulnerability Index based on DFID model on Sustainable Livelihood Framework. Finally, interview and focused group discussions were conducted amongst various stakeholders about the issues related to understanding barriers to adaptation and diversification of livelihoods.

Findings:

- (i) Coastal households are more vulnerable than non-coastal households in all the five capitals. Major differences are observed in natural capital (0.188) followed by physical capital (0.125) and human capital (0.100). There are seven components out of twelve components where the differences were significant. These are forest based livelihood (0.394), drinking water (0.394), land vulnerability (0.100), knowledge and skill (0.182), health vulnerability (0.169), physical capital (0.125) and assets vulnerability (0.109).
- (ii) Coastal household representing marginal communities living below poverty line having female headed household are the most vulnerable whereas non-coastal households representing general caste communities living above poverty line having male headed households are the least vulnerable categories amongst the 16 groups.
- (iii) The DRM programme of the state should include development-based activities in addition to disaster specific risk reduction measures, so that resilience capacity of the various households will be enhanced.

Significance for practical solutions: The findings will be submitted to National Institute of Disaster Management to disseminate with different stakeholders training programme. This will also be forwarded to the State Disaster Management Authority and Department of Sunderbans Affairs and concerned District Administration of Government of West Bengal for suggestions and implementation.



ABSSUB-433

Towards a disaster risk reduction lessons learned portal for El Niño: insights from South Africa

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Research question: In the short span of 25 years from 1972 to 1997 thoughts about El Niño changed dramatically from one of scientific curiosity to one of having become a household word in many countries. El Niño is quasi-periodic returning now and again in any given decade. When it is forecast, societies start to wonder if or when they must "do something" to get prepared. As it ends, however, societies quickly lose interest in the phenomenon... until the next event. This project aims at identifying, collecting, analysing and sharing lessons learned from previous El Niño events in South Africa in order to build preparedness in the face of increasing vulnerability to extreme events. The main question is: what are the lessons learned from past risk management and how can we use them more effectively to prevent or reduce future El Niño-related impacts?

Methodology: A considerable number of publications, including reports by governments and hydromet services, already exist about impacts and responses to previous El Niño. These publications were reviewed to identify lessons and recommendations, and to compare them from one event to the next in order to see if lessons identified were actually addressed or did appear again in the following El Niño event report. In addition, interviews were conducted with key stakeholders in South Africa to complement the data on how disaster risks are managed. Lessons from South Africa will be compared with other case studies in Central America, Asia and the Pacific Islands to identify trends in the management of El Niño related impacts worldwide.

Findings: This is an ongoing project ending in September 2016. So far, results indicate that the management of El Niño-related impacts (e.g. drought) in South Africa remains oriented toward a reactive relief response strategy as opposed to a more proactive policy that could be based on lessons learned from past events. Although a more proactive drought management strategy emerged in the late 1990s (on paper), evidence on the ground indicate that DRR remains rooted in relief solutions.

Significance for practical solutions: This project involves researchers, practitioners and decision-makers. Findings will serve to design a web-based portal for the DRR and CCA communities to discuss lessons identified or learned by governments, NGOs, Youth groups and educators. Shared lessons from past El Niño events can serve as an early warning for foreseeable DRR disaster related to El Niño.



ABSSUB-585

Coping with flooding in informal settlements in rapidly urbanising peripheries in the Mumbai region

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Research question: Since the late 2000s, there has been an increasing scholarship on the coping and adaptation strategies adopted by the urban poor in the global South in response to climate-related risks such as flooding. More recent work has also examined the role of specific factors such as social capital, income, tenure security, and quality of housing in affecting adaptive capacities and shaping coping strategies towards urban floods at the household and community levels. However, most of this knowledge is based on cases from megacities despite a majority of urban population growth projected to take place in smaller cities in Asia and Africa. This poster attempts to contribute to this gap by examining coping and adaptation to flooding risks in Kalyan-Dombivali and Navi Mumbai – two mid-sized, satellite cities located on the peripheries of Mumbai in western India. In this poster, we examine and articulate the differences between risk perception and coping by residents in old and new informal settlements, gaps between community expectations and municipal disaster management responses, and recommend opportunities for effective adaptation through a more integrated approach.

Methodology: This poster is based on three months of field work carried out between June to August 2015 in the Mumbai region. We conducted qualitative semi-structured interviews with 123 households in six flood-prone informal settlements in Kalyan-Dombivali and Navi Mumbai to understand household level flooding risk perception and coping strategies. We also interviewed ten officials at the city and subnational scales, and examined disaster management plans to understand institutional measures to build adaptive capacity, and reduce flooding impacts.

Findings: We find differences between the risk perception and coping strategies of residents in new and old informal settlements in these cities - the latter are more likely to perceive risk and make physical changes to their houses to reduce flooding; whereas the former do nothing. New residents are also less aware of early warning systems, and more likely to relocate if they are provided cheap, and conveniently located alternatives. City governments exclusively use rescue and relief approaches after flooding occurs instead of a proactive risk reduction approach. This is due to a lack of knowledge and institutional capacity, and higher public reliance on political leaders to deliver basic services and relief.

Significance for practical solutions: By highlighting flooding risk perception and coping measures by the urban poor in smaller urban areas in India, and gaps in institutional measures, this poster makes a significant contribution to the literature on urban disaster risk reduction in the global South. We also make recommendations to improve city government capacities and disaster management in new informal settlements through infrastructure provision, land use regulation, and communication measures to increase community awareness on effective coping measures to counter their lack of experience.



ABSSUB-379

Vulnerability of Almeria watershed to man-made and natural hazards

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Research question: What is the vulnerability level of Almeria watershed to man-made and natural hazards?

Methodology: Coordination and courtesy meetings with local government officials of Almeria were conducted prior to the actual assessment to ensure their full support followed by the agreement on the schedules for the interviews and focus group discussions (FGD). Immediately thereafter, FGDs and actual surveys of the watershed were simultaneously undertaken. Key informant interviews were also conducted to collect data not discernible through FGDs. The manual on Vulnerability Assessment (VA) developed by the Ecosystems Research and Development Bureau (ERDB) was used as basis in providing ratings on vulnerability, to wit: 1: Factor plays in Very Low Vulnerability of the watershed, 2: Factor plays in Low Vulnerability of the watershed, 3: Factor plays in Moderate Vulnerability of the watershed, 4: Factor plays in High Vulnerability of the watershed, and 5: Factor plays in Very High Vulnerability of the watershed.

Findings: Results showed that Almeria Watershed has low vulnerability rating of 2.15 in relation to flooding but extreme rainfall events caused destructive floods in the low-lying areas while landslides and soil erosion has a vulnerability rating of 2.2. Vulnerability in relation to biodiversity loss is 2.15, then 2.23 for forest fires, and 2.30 for resource degradation. Vulnerability of the river water to pollution is 3.0 due to the high coliform count while resource degradation has a vulnerability rating of 2.30. Coping mechanisms adopted included evacuation from areas prone to floods, landslides and soil erosion but some residents stayed where they are despite the issued warning due to the absence of suitable settlement land and job opportunities. The use of lesser known species for local construction to replace premium trees that are gone due to illegal cutting and minimise use of sand and gravel through stern local ordinance were mentioned. Effective policy implementation and stronger cooperation among residents and local officials is necessary to achieve significant disaster risk reduction.

Significance for practical solutions: The Department of Environment and Natural Resources in cooperation with the Disaster Risk Reduction and Management Office of Almeria can use the result in designing policies for early warning system, coping mechanisms, mitigating measures and other related disaster risk reduction strategies.



POSTERS - THEMES
6. DISASTER RISK REDUCTION



ABSSUB-527

Communicating climate change: exploring effects of climate change and adaptation training workshops

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Research question: The communication of Climate Change and Adaptation (CCA) information is gaining an increasing amount of attention in research and in practice. This is potentially due to an observed lack of interest despite the growing body of evidence that supports climate change impacts. Researchers in behavioural science argue that more information does not necessarily lead to behavioural change and/or action. However, a link does appear to exist between behaviour and attitude. In communication studies, it has been found that how information is presented and transferred is important in influencing people's attitudes. This observation can be applied in the climate change discourse. It is argued that the way in which CCA information is communicated is key in influencing attitudes and perception of CCA, and could therefore influence behaviour and adaptive action further down the line.

Methodology: Data collection focused around two sets of training workshops. The first training workshop was one week long with a total of 17 research participants; the second workshop was 10 days long with 20 research participants. The Climate System Analysis Group, a research group in South Africa at the University of Cape Town, ran these training workshops, which are aimed at mid-career professionals that are engaged in decision and policy development. Quantitative data was collected using online surveys. This data was used to assess changes in participants' knowledge, perceptions, and attitude towards CCA before and after the training workshops. Survey results, coupled with qualitative process observation, feedback sessions, and semi-structured interviews were used to identify the communication modes and elements of workshop design that enhanced the participants' understanding of CCA.

Findings: This research project was able to identify 'CCA training workshop' conditions that facilitate an increase in participant understanding of CCA. Major results indicate that most of the participants experienced positive changes in their perceptions of and attitudes towards CCA issues after attending a training workshop. It is also clear that participants were most able to understand the issues being taught when a number of different modes of communication were used throughout the training process. Teaching methods that involved games and role-playing proved very successful in communicating adaptation concepts, however the traditional lecture format was needed to provide context for the games. It is argued that a diversity of methods be used when communicating CCA information to non-expert audiences.

Significance for practical solutions: The effective communication of CCA information to professionals that are engaged in decision and policy development is key to adaptation at scale. It is therefore critical that these CCA workshops are designed in such a way that facilitates learning and understanding of the issues. This research highlights an array of examples of good practice, which might inspire future CCA communication efforts.



ABSSUB-696

Adaptation research - getting information into the right hands

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Research question: Adaptation as a field of enquiry is an increasingly busy space. Research is rapidly generating information about the risks and impacts of climate change, how it can be tackled through strategic approaches, decision-making processes and balanced adaptation actions. The sheer volume and associated complexity of new information and the rapid evolution of ideas makes it difficult for time-poor practitioners and decision makers to access and use, creating a risk that investment in adaptation research is not translated to action. This paper looks at an Australian experience of developing and communicating relevant research synthesis in a format that meets stakeholder expectations.

Methodology: Australia's National Climate Change Adaptation Research Facility (NCCARF) invested \$30 million into adaptation research between 2009 and 2013. The investment yielded arguably one of the most significant, wide-reaching research efforts on adaptation to date. The magnitude of the work and the short delivery timeframe (within three years) left a legacy of complex, technical information on a variety of topics. NCCARF is now undertaking a synthesis and communication programme to condense, synthesise and translate that information into digestible communication products for a diverse audience of end users. To shape the delivery of this programme we held two online workshops and a series of one-to-one interviews with stakeholders.

Findings: The results of our consultation informed the mode of delivery and the key challenges to be addressed and led to design of a series of 10 synthesis summaries. To increase the relevance of our products to a large diversity of end-users, we are preparing a set of actor specific briefs from the synthesis products that provide key messages for each set of actors (e.g. elected officials, Council planner and engineers). We will present the outcomes of a two-step stakeholder consultation process and the testing of the synthesis and communication products which have emerged from that process.

Significance for practical solutions: Unless practitioners can access research to support their adaptation, research fails to inform practice. Practitioners often cannot access to subscriptions of journals, or have little time to develop an understanding of technical reports. Our programme is a useful test of how we communicate this information in a way that is driven specifically by the needs of stakeholders.

ABSSUB-830

Shaping climate resilient development - open-source adaptation

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Research question: Adaptation measures are available to make societies more resilient to the impacts of climate change. But decision makers need the facts to identify the most cost-effective investments. Climate adaptation is an urgent priority for the custodians of national and local economies, such as finance ministers



and mayors - as well as to leaders in the private sector. Such decision makers ask: 1) What is the potential climate-related loss to our economies and societies over the coming decades? 2) How much of that loss can we avert, with what measures? 3) What investment will be required to fund those measures - and will the benefits of that investment outweigh the costs?

Methodology: The Economics of Climate Adaptation (ECA) methodology provides decision makers with a fact base to answer these questions in a systematic way. It enables them to understand the impact of climate change on their economies - and identify actions to minimise that impact at the lowest cost to society. It therefore allows decision makers to integrate climate adaptation with economic development and sustainable growth.

Findings: Economics of Climate Adaptation (ECA) case studies in more than 20 different regions around the globe, ranging from cities such as Barisal in Bangladesh or San Salvador in El Salvador to countries such as Mali or Samoa, showed that up to 65% of expected damage from climate change could be averted by cost-effective adaptation measures.

Significance for practical solutions: The New York city (NYC) (climate) resilience plan was based on the Economics of Climate Adaptation (ECA) methodology and led to investments of USD 16 billion in 2013/14. Case studies in the Caribbean support the Caribbean Cat Risk Insurance Facility (CCRIF.org). Using state-of-the-art probabilistic modelling, ECA allows to assess the expected economic damage as a measure of risk today, the incremental increase from economic development and the further aggravation due to climate change. Through intense dialogue with local stakeholders, a portfolio of adaptation measures to address weather and climate risks has been established in each case study. Proposed measures usually include preventive projects, intervention as well as risk transfer solutions. ECA allows to quantify cost and benefit of each measure and therefore provides decision-makers with the facts to develop their local adaptation strategy, an implementation roadmap and business case and hence increases access to (climate) resilience funding.

ABSSUB-588

Measuring and predicting the effect of land use change on climate adaptation capacity

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Research question: Climate change and urbanisation are two of the most difficult challenges facing society today. The relationship between urban development and climate change is complex, with various effects that are geographically dependent. Thus, local adaptation strategies become increasingly important under this context. Considering both environmental and social factors, an important question is how does current land use development affect capacity to deal with climate change at a local level? In areas that are undergoing massive land use change, how will adaptive capacity be influenced?

Methodology: To answer these questions, this research aims to create an indicator system specifically targeted at areas in transition, which can measure adaptive capacity and predict its future capacities under various scenarios to assist decision makers and policy builders in planning climate adaptation.

A land-use based climate adaptive capacity indicator system was constructed based on previous literature,



including both biophysical and socioeconomic factors, using data from government census surveys, reports, and historical documents. These indicators are applied to years 2000 and 2010 as a baseline, and use regression to predict indicator values to 2030 along three land use change scenarios for two case study sites. AHP is used to weight indicators. Three land use scenarios are used in this research, which are based on a simplification of IPCC narratives (2000). The first scenario is Business as Usual, the second is an economically/development oriented scenario, and the last is an environmental and socially driven scenario. Land use data was analysed in ArcGIS and scenarios are created using What If? software. The two case study sites used were Tamsui, Taiwan, and West Palm Beach, Florida, US. Both are areas that have experienced significant growth, and are slated for more development in the next decade, making them interesting cases for international comparison of how these changes affect adaptive capacity.

Findings: Land use development is both increasing and decreasing capacity to adapt to climate change. In both sites, as many biophysical indicators show a decrease in adaptive capacity, many of the socioeconomic indicators show an increase. Between the two sites, Tamsui maintained more biophysical adaptive capacity under BAU, whereas West Palm Beach maintained more socioeconomic by ways of high economic resources.

Significance for practical solutions: This research provides a system to measure adaptive capacity for localities undergoing significant development which can be used by local policy makers to understand how development may impact their communities. This research can highlight specific capacities that are increasing or decreasing to help target strategies and resources, and also provides an international comparison for wider contextual discussions.

ABSSUB-763

Adaptation to the impacts of climate change in Scottish Island communities

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Research question: The Scottish Islands are peripheral locations that are physically exposed to storms and coastal flooding; the frequency and magnitude of which may be exacerbated under changing climatic conditions. Of the inhabited Scottish isles, 93 islands are home to 103,702 people, spread over a geographic region of 10,300km². Key questions remain about the priorities for small island adaptation to the impacts of climate change. The research seeks to review and develop theory on the scale of adaptation measures and consider the appropriateness of top down vs bottom up measures, given the diversity of Scottish island contexts. The research addresses the following questions: (1) what are the priorities for adapting to climate change in small island communities, specifically in the Scottish Islands? (2) Do the priorities differ across small island communities and, if so, why? (3) What are the implications for future adaptation planning?

Methodology: Communities in South Uist (Outer Hebrides), Westray (Orkney) and Unst (Shetland) were taken in a multiple-case study approach as part of the research. A series of six focus groups were used to explore local perspectives on climate change impacts, as well as motivations and priorities for adaptation. Drawing on naturally occurring social groups, the focus group approach allowed the reconstruction of community viewpoints, as opposed to individual perceptions of climate adaptation. The coding of qualitative data from focus groups led to the emergence of key themes relating to community understandings of climate change and adaptation priorities.



Findings: The findings highlight issues of importance for adaptation within each case study, and show significant variation across all study communities, despite the communities being of similar size, demographic and island context. The outcomes of the research also indicate local motivations behind adaptation priorities. Findings specifically cover priorities related to key adaptation issues: (1) Settlement and Housing (2) Transport and Infrastructure (3) Economy and Local Industries (4) Health, Safety and Wellbeing (5) Cultural Heritage.

Significance for practical solutions: The research contributes to the debate on 'one-size-fits-all' adaptation planning. The findings support the argument that a uniform approach to adaptation across scales is not sufficient when local priorities differ significantly. Furthermore, the study raises key considerations about the balance of applied and academic research. By taking local motivations and priorities into account during processes of planning and action, future adaptation will have greater practical benefit for the case study communities. Local stakeholders, community members, and local authorities in Shetland, Orkney and the Outer Hebrides can use the findings as they see fit. The research develops a deeper understanding of island adaptation planning and there is scope to apply a similar approach to understand priorities in other small island settings.



ABSSUB-330

Situating climate change risks in socio-economic vulnerabilities: case study from northern Ethiopia

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Research question: What are the core risks that expert and local communities consider important? What the sources of these risks? How do experts and local communities frame these sources of risks? How do different sources of risks interact and where are climate risks situated in these multiplicities of sources of risks?

Methodology: The study uses qualitative methodology, conducted over eight month time field work in Northern Ethiopia, Amhara Regional State, North Wollo Zone, Gubalafto and Kobo Districts. Data was collected using 60 in-depth interviews, 12 focus group discussions, and a number of field observations. The Data was analysed using MAXQDA qualitative data analysis software.

Findings: Six different sources of risks, here called riskscapes were identified. 'Naturalized riskscape,' is widely held among the expert and local communities alike, where by some fixed aspects of the bio-physical environment or its intra and inter annual variability, such as topography, climate risks, pest outbreak are considered to be the sources of risk. In 'subsistence riskscape', due to absence of other alternative livelihood options, experts argued, farmers exhausted their environment beyond its limits. 'Demographic riskscape' attributes high population pressure to farmland fragmentation and over exploitation of natural resources. The local people's also identified 'market volatility riskscape', engagement in volatile input as well as output markets and 'government blames riskscape', where by local communities accused of government officials of forcing them to engage in risky farming practices or limit their access to critical resources. Finally, expert practices blame experts themselves as a source or risk; in 'leadership failure riskscape' experts attribute food security and poverty to failure of the expert and political leadership.

Significance for practical solutions: Such analyses enrich our understanding of the way climate risks manifest themselves and interact with other risks. It also helps us to understand the rationale behind coping/adaptation practices perused by both the state and local communities. Such social analysis could help us to look beyond the promises of technical recommendations and consider their social and political dimensions. What are the historical experiences of these interventions? Which of the riskscapes do they address? Who has the power to decide on what adaptation is and what is not? Such analysis has the potential to identify unpopular intervention and design better once.



ABSSUB-374

The 'future cities adaptation compass' – a tool to assess vulnerability & adaptation options easily

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Research question: The urban living environment is highly vulnerable to the consequences of climate change. Well-functioning city regions are on the other hand one important factor for sustainable economic development. The research question for the INTERREG IV B NWE project "Future Cities" was: "How to develop anticipatory strategies for adapting urban structures in a way that the impacts of a changing climate will not endanger the urban living environment, taking into account remaining uncertainties as well as cost-effectiveness and sustainability resp. mitigation aspects."

Methodology: FUTURE CITIES has developed the Adaptation Compass to assess vulnerability and adaptation options across different policy fields. It helps planners, experts in cities and water authorities to plan a step-by-step transition to create climate-proof cities. The Adaptation Compass can be applied to regions, cities or project areas, but provides the best results for cities.

The Adaptation Compass is based on the approach of risk management, structured in 5 modules and a monitoring loop:

1. Determine the current vulnerability of a region or a city with the VULNERABILITY CHECK.
2. The module UNDERSTAND CLIMATE CHANGE EFFECTS helps to get the relevant information and to cope with uncertainties.
3. The ASSESSMENT OF RISKS AND OPPORTUNITIES method is using the results of the vulnerability check and the projected climate change effects.
4. The module EXPLORE ADAPTATION explores the various adaptation options - especially the combination of different measures based on the practical experiences of the Future Cities partnership.
5. Finally the NEED FOR ACTION can be determined. The core problems and areas are identified and suitable adaptation measures can be put in place.

The user can save the results, REVIEW input data later and update, if required. Examples for MONITORING the results of measures are also provided.

Findings: In a city most departments are facing the impacts of climate change. They must adapt their policy and practice. Measures taken by one department might also meet the adaptation needs of another. On the other hand the adaptation action may conflict with the urban structure. The Adaptation Compass is organising this process. It brings together all relevant actors, cross-sectoral and target-oriented. Especially the module "Check Vulnerability" makes use of the available experience-based know-how that is at hand in the city resp. region. This empowers any public body to adapt to the impacts of climate change even with low budget but high challenge.

Significance for practical solutions: The Adaptation Compass supports decisions of the city council/ management board to discover practical solutions quick and easy. Based on the practical experience of the Future Cities partners and can be transferred to any city / region within the EU, and also beyond. After the Future Cities project was completed, the Compass was already be used in over 14 German cities and 3 municipalities beyond the EU (Belgrad/Serbia, Podgorice/Montenegro, Tirana/Albania).



ABSSUB-289

Adaptation to climatic hazards in coastal Taiwan communities: Building effective warning systems

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Research question: The coastal region in Asia-Pacific is one of the most vulnerable and disaster-prone areas to the threats of climate change and extreme events. How to encourage private (autonomous) adaptation to reduce climate-related (climatic) hazard risk is a challenge for local agencies. Most countries (such as the Adaptive Strategy to Climate Change in Taiwan) focus on planned (anticipatory) adaptation, which is a top-down and frequently combined with various hazard warning systems to frame the strategies to climate change and disaster risk management. However, there is a shift towards incorporating private adaptation elements into adaptation planning and warning system building to reach the most vulnerable people and to enable stakeholders' participation in channelling the process of decision-making. This study thus aims to improve the knowledge about the households' pre-disaster and post-disaster adaptive behaviour in coping with climatic hazards and their determinants.

Methodology: Coastal households' autonomous adaptation can be reactive or anticipated. Numerous factors can influence whether people autonomously take actions to respond to climatic hazards, such as information availability, adaptation appraisal, socio-cognitive and socioeconomic attributes. Especially, adaptive behaviour is based much on the elements regarding risk information dissemination, local understanding of risk and socio-contextual variability among community members. This may cause residents' adaptive behaviour to unfold as a clustered pattern across the coastal communities, rather than one that is randomly distributed. Therefore, using a case study of the north-eastern coastal Taiwan communities, we create the Model of Household Adaptation to Climatic Hazards (MHACH) from existing socio-psychological knowledge. A GIS (Geographic Information System)-based spatial statistics technique and multivariate analysis are then incorporated into the MHACH to test the degree to which the adaptive actions are spatially auto correlated throughout the coastal areas, and explain why clustering adaptive actions occur in specific areas.

Findings: Results show that both the residents' pre-disaster and post-disaster adaptive behaviour are significantly spatial correlated across the study areas. Simply increasing public hazard risk awareness is insufficient to encourage autonomous adaptation. The key factors that influence households' adaptive behaviour further include perceived risk, adaptation appraisal, socioeconomic attributes, as well as the extent of their trust in information, interaction with neighbours and abilities of access to resources.

Significance for practical solutions: To enhance adaptive capacity, the policy line can be targeted based on the aforementioned factors that influence adaptive behaviour. Especially, improving risk communication, public participation and social trust play a critical role in building effective hazard warning system, and are also helpful to achieve the full scope of benefits in the process of adaptation planning.



ABSSUB-494

When is it 'good enough'? Comparing datasets for tick-borne disease surveillance and adaptation

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Research question: Monitoring of geographic changes in tick-borne disease incidence over time has been established as an adaptation strategy. Vector surveillance is largely dependent on presence and absence data, the quality and availability of which can vary. To increase capacity for monitoring, also in lower income countries and regions, publicly available tick distribution datasets are required for the modelling of future health risks from these vector-borne diseases. Little is known, however, on the respective accuracy of modelling with different datasets, and whether the benefits of more comprehensive data outweigh the potentially higher costs. This study compares three datasets by projecting current and future distributions of *I. ricinus* ticks in Europe.

Methodology: Ecological niche models were created for *I. ricinus* using the Generic Algorithm for Rule-set Prediction (GARP). A total of 8,371 *I. ricinus* georeferenced occurrence locations were compiled from three sources: 2,097 locations from Global Biodiversity Information Facility, 1,855 locations from a new German tick database, and 4,419 locations from a comprehensive tick database for all of Europe. Current and future *I. ricinus* distribution in Europe was modelled using the GBIF dataset only, then a second set of models were created using the two non-GBIF databases. Baseline climate data were based on the time period 1990–2010 and the future distribution model utilized the CSIRO SRES A2 scenario for the time period 2040–2060 and bioclimatic grids created by downscaling with the MarkSim technique. Areas of potential expansion and contraction were determined by level of agreement between the current and future projection models of *I. ricinus*. Finally, results from the projection were compared.

Findings: A comparison between the GBIF models and non-GBIF models shows concurrence with regard to contraction in the Pyrenees, inland Italy, and Poland. With regard to expansion, concurrence was found in predictions for Italy and the Scandinavian countries, but not those of the Baltic States nor Belarus. While the modelled tick distributions are comparable for all three sets in northern Europe, southern and eastern areas of Europe exhibit a much more suitable environment for *I. ricinus* using the more comprehensive, up-to-date dataset. Regarding accuracy metrics, however, the more comprehensive model showed a lower AUC score of 0.66 as opposed to the original model with 0.91.

Significance for practical solutions: Results suggest that while more comprehensive datasets increase the specificity of niche projections, the GARP modelling approach can already provide robust estimates of future niche suitability with fewer data points. The validity of accuracy measures needs to be studied further, and cost-benefit analyses might prove a useful addition. These findings indicate that, depending on the study area, even less exhaustive data can provide useful information for vector-borne disease impact and adaptation analyses and strategies, which has implications for lower income contexts.



ABSSUB-680

Insights on bringing climate change adaptation on to the sub-national political agenda in Ecuador

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Research question: The German Development Cooperation (GIZ) has been advising the Province of Tungurahua in Ecuador for over a decade on topics of sustainable agricultural production and natural resource management. As climate change and its impacts become ever more evident in Ecuador, GIZ and its counterparts in Tungurahua have embarked on an exploratory journey over the last years to find out what the key elements are to get climate change adaptation onto the agenda of local governments and other key stakeholders.

Methodology: From the onset it was clear that adaptation efforts should focus around protecting the fragile highland páramo ecosystem, which acts as an important water regulator for much of the province and other parts of Ecuador. Faced with melting glaciers and projections of reduced precipitation in the region, it is of utmost importance to safeguard the páramos to ensure future water availability. A multi-pronged approach was taken to explore how best to bring adaptation onto the agenda in Tungurahua : (1) an empirical study of the current state of the páramo, which also considered potential climate change impacts was published and presented to government officials, NGOs and universities; (2) A partnership was formed between GIZ and a credits cooperative to offer local farmers attractive credits that had in-built conditions to safeguard the páramo; (3) Officials at different scales of local government received training on climate change and included the topic in the revision of their local development plans; (4) A systemic analysis of risks and management strategies of two conservation sites was undertaken with park rangers, local government officials, representatives of the Ministries of Environment and Agriculture and farmers.

Findings: Our experience over the last few years has shown that it is precisely the mix of methods targeting different stakeholders in Tungurahua that has contributed to climate change slowly making it on to the political agenda. The empirical study can convince decision-makers with numbers; private sector involvement demonstrates that funding for adaptation measures exists; including climate change in development plans adds to the legitimacy of tackling the issue; and systemic risk analysis workshops are key for stakeholders to see beyond their own interests and highlight the need to cooperate for a collective good.

Significance for practical solutions: Much remains to be done. The real work is in sustainably implementing what is on paper, monitoring the progress and adjusting the developed strategies if necessary. Our experience has shown the value of linking climate change to urgent local needs, such as water availability; otherwise, it may be perceived to be too abstract at subnational levels. And finally, while there is no formula for how to get adaptation on to the agenda of local governments, addressing climate change should be a multi-stakeholder goal and a mix of methods should be utilised to involve different stakeholders with varying interest and capacities.



ABSSUB-654

Role of participatory approaches and communication in the implementation of the NAPAs and NAPs

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Research question: This research aims to explore how participatory approaches and communication methodologies have been used in the design and implementation of National Adaptation Plan of Actions (NAPAs) to detect lessons learned and to understand how the use of these approaches can be improved and used for the development of National Adaptation Plans (NAPs).

Methodology: The research methodology has been as following: 1) Desk analysis of documents related with NAPAs, NAPs, participatory approaches and communication methodologies. 2) Explore how participatory approaches and communication methodologies have been used in the design and implementation of NAPAs in Ethiopia. 3) Realization of face to face interviews (almost 50 experts) and survey to stakeholders identified such as policy makers, international and local institutions, and communities involved in the realization of NAPAs or experts on climate change and participatory approaches and communication (almost 3000 participants). 4) Analysis of data to detect lessons learned and recommendations to understand how the use of these approaches can be improved and for the development of NAPs.

Findings: The participation of all stakeholders at the design and implementation of NAPAs and NAPs is crucial for having a complete and effective adaptation impact. The involvement of people at the grassroots-level is essential to greatly improve the quality of decisions by rendering the process more efficient and effective. The major benefit that is derived from engaging the public and stakeholders in participatory processes is the creation of knowledge base for informed and responsible decision-making. Engaging the public and stakeholders early in the process helps generate information and reveal societal preferences, especially of those groups most directly concerned with a project or policy under development. Moreover, early engagement of people at the grassroots level will permit to increase empowerment in the population so to ensuring successful implementation of NAPA activities because outcomes thus become more legitimate and credible. In addition, the involvement of stakeholders and local communities builds local capacity.

Significance for practical solutions: Mapping stakeholders permit to include strategic actors; Involve stakeholders from the beginning permit to increase empowerment in the population so to ensuring successful implementation of NAPA activities because outcomes thus become more legitimate and credible; creating a knowledge base that reflects general preferences permit to have conceived projects responsible to the needs and concerns of local communities; use an understandable communication for all stakeholders enable all to participate.



ABSSUB-907

Knowledge empowering adaptation: climate change, sea level rise and local governments

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Research question: Coastal areas are some of the most vulnerable to climate change, with high population densities, valuable infrastructure, and exposure to windstorm, storm surge and inundation. Addressing the risks of climate change is generally the responsibility of local councils. Due to lack of resources and expertise, as well as conflicting pressures from stakeholders, councils may struggle to fulfil this responsibility. How can local governments be supported to ensure timely and effective adaptation?

Methodology: Through extensive consultation, we were able to identify four attributes of support that local councils, especially the less well resourced, and other coastal managers require in order to undertake coastal adaptation. These are: capacity, confidence, knowledge and tools. Together, the four provide a support system for adaptation to climate change and sea-level rise in the coastal zone.

Findings: Bearing in mind the four attributes, NCCARF is developing CoastAdapt, a support system providing information and decision support for coastal managers. CoastAdapt is built around five themes: present climate, future climate change and sea-level rise, impacts, action, and engagement. The first three primarily address the provision of information required to underpin and guide adaptation, together with guidance on, for example, how to select and use climate change scenarios and how to carry out a vulnerability assessment. They feed into the fourth theme on adaptation action. This provides information on topics such as incremental and transformation adaptation, maladaptation and adaptation pathways, together with a decision support system that steps users through an iterative process from scoping the risks through to identification and implementation of actions and, finally, monitoring and evaluation. The fifth theme supports users to engage and consult with their stakeholders, whether elected representatives, senior management or the community. It will include an online forum for networking and advice provision. CoastAdapt will be web-based, and use innovative delivery mechanisms including videos, webinars, infographics and cartoons. Through use of a single pen, we will ensure the language is at a level accessible to its user community.

Significance for practical solutions: CoastAdapt empowers coastal managers to take action to address climate change and sea-level rise, and to integrate climate change into wider decision-making processes.

ABSSUB-1044

Participatory development and application of progress indicators for local adaptation plans

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Research question: Adaptation planning at every scale faces the enormous challenge of developing and applying tools for evaluating planning effectiveness, and a lack of means for evaluation and subsequent indication of progress threatens the capacity of adaptation measures to gain political and economic backing. Particularly at a local level, the difficulty of designing tools and indicators for adaptation evaluation is coupled



with the challenge of ensuring the continuity of resources and political will necessary to carry out evaluation, during and following the implementation of short- and medium- term projects. "Climate Change Academies" were designed and implemented with local governments throughout South America to build capacity within existing technical teams for participatory design, implementation and monitoring of local climate change adaptation plans, with special emphasis placed on developing means of implementation and progress indicators for each action associated with local climate change plans.

Methodology: Three-day intensive training workshops served to build capacity in existing local technical teams for the implementation of a step-by-step methodology for the development of local climate change adaptation plans during workshops undertaken with a combination of local government actors, community members, representatives of the private sector and civil society. Indicators of vulnerability and adaptive capacity were applied and local climate change profiles and risk maps developed in order to identify primary strengths and weaknesses and prioritize areas for intervention. Concrete means of implementation and indicators to evaluate the implementation and continuity of the plan were developed in a combination of small group and plenary session activities led by local technical teams.

Applied methodology included steps for evaluating and selecting indicators based on existing criteria proposed by Wautiez and Reyes (2000), including quantifiability, relevance, binding nature, validity, cost-effectiveness and comparability. Indicators were developed for each specific action associated with local plans, and technical teams were encouraged to explicitly identify roles associated with these indicators, including those responsible for information collection and analysis.

Findings: This research represents an ongoing process of monitoring and evaluation of over 20 municipalities throughout the region, which will serve to shed further light upon the challenges of achieving, evaluating and demonstrating the success of adaptation practices at a local level.

Significance for practical solutions: The initiative centers on the need for locally developed and implemented solutions to local challenges in order to ensure that planning, implementation and evaluation processes can be achieved with existing resources and capacities, in this way increasing the potential for the continuity of these processes over time and in the context of political and economic transitions.

ABSSUB-1032

A global analysis of adaptation case studies: state of the art

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Research question: Which green, grey and soft adaptation measures are already implemented in different countries globally? This paper takes stock of adaptation planning and measures to date in Europe and globally. The paper provides a general assessment of 136 selected case studies focusing on aspects including types of measure, stakeholder groups involved, sectors, decision support tools (participatory and economic), and funding sources.

Methodology: The analysis of adaptation measures is based on desk based research. As a first step, a matrix was developed to collect case studies. The gathering of case studies started with a review of European and international database focusing on climate change adaptation case studies, e.g. INFOBASE, Global



Adaptation Network, CAKE. This review was complemented with a general internet search and a screening of national databases. The countries reviewed were selected to cover a wide geographic spread, spanning Europe, North America and South America taking into account the European and other world regions already covered by BASE project (EU-FP7) and its partners.

Findings: This report highlights the use of grey, green, and soft measures to adapt to climate change in Europe and globally. Moreover, it seeks to identify and describe how participatory and economic methods were used in specific examples in the design and implementation of adaptation measures. A first result is that the databases can be improved in regard to usability, information available, and ease of understanding. In many instances, the databases had significant information gaps or lacked clear information. The 136 identified case studies offer a broad mix of examples of measures implemented to adapt to climate change both in European and non-European countries. Soft measures are the type of measure most often implemented, with 47% in Europe and 56% in non-European countries analysed. Public administration bodies on different levels are the main stakeholders included in the reviewed case studies – with 80% representing this group in Europe and 76% in non-European case studies. In terms of scale, the focus is 65% on the local level and 29% on the regional level. In regard to the sector, most case studies focus on biodiversity and ecosystems (35%) and coastal marine systems (33%). The general assessment also identified participatory methods in 66% of the case studies and economic evaluation methods in 38%. Public funding is also the main source for financing both European and non-European case studies.

Significance for practical solutions: The analysis shows the most implemented types and characteristics of adaptation measures. All measures are already implemented, so it is a screening of measures already in practice. Individual examples for green, grey and soft measures are mentioned and can be a source to knowledge, experience and inspiration for a better Adaptation in the near Future.

ABSSUB-1293

Evaluating the effectiveness of climate change communication and discussing future research

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Research question: This study asks the question how effective climate change communication is in fostering engagement with climate change adaptation among individuals. Climate change communication (CCC) includes efforts to raise awareness about climate change and promote behavioural change to mitigate its risks by engaging a target audience with climate science and its practical applications.

Although CCC has become popular among governments and scientists wanting to promote adaptation, comprehensive quantitative studies of how effective it is in changing mind-sets and behaviour are largely absent from the scientific literature. In this paper we close this gap and provide insights into the outcomes of a large CCC project in Sweden. Based on these results, we formulate recommendations for future research on CCC and discuss common methodological and conceptual approaches and standards.

Methodology: The empirical data of this study comes from a survey of 6000 forestry owners in Sweden. Half of these forest owners took part in a CCC project run by the Swedish Forestry Agency. Participants in this



project were given information and practical guidance about the risks of climate change and viable adaptation measures. The study assess if perceptions and attitudes about climate risks and adaptation measures differ significantly between forest owners that have and forest owners that have not participated in the CCC project. Statistical methods used include multivariate regression analysis, cluster analysis and facto analysis. Those methods are used to estimate the effect of CCC on the perception of climate risks, perceived efficacy of adaptation measures, perceived self-efficacy and actual adaptive action of participants and non-participants of CCC.

Findings: Findings show that CCC has a statistically significant influence on the level of individual engagement with climate change adaptation. Results show that forest owners that had participated in CCC had higher perceived adaptive capacity, trust in climate science and readiness to take adaptive actions. Findings also suggest that personal views on forestry objectives, such as timber production or nature conservation had marginal influence on the effectiveness of CCC.

Significance for practical solutions: This study offers valuable insights for politicians, activists and scientists into how effective they can be in using communication and scientific information to raise awareness and promotive behavioural change for adaptation. Results from the study also offer valuable lessons about how future practical efforts and research on CCC need to address individuals values, objectives and social norms to be more successful.

ABSSUB-1420

Towards a methodological framework for participatory research on adaptation in a sectorial context

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Research question: What characterises an effective science-based stakeholder dialogue and arena for collaboration, mutual learning and decision-making on climate change adaptation? How can research on climate change, impacts and adaptation be combined and effectively communicated to support adaptation decision-making amongst relevant stakeholders?

Methodology: Over the course of 8 years, we have developed, tested and fine-tuned a participatory methodology on climate, impacts and adaptation in the Swedish context. In the first programme phase, conventional research on climate scenarios and impact assessments was complemented by participatory research involving municipal and forest stakeholders. This research took the form of science-stakeholder dialogues which aimed to elicit stakeholders' perspectives about adaptation and offer a platform for mutual knowledge exchange between scientists and stakeholders. In its second phase, the scope was widened and redesigned to enable an interactive science-stakeholder dialogue and to directly address stakeholder's questions and needs. The outlined and proposed methodology encompasses targeted climate change communication for forestry owners and professionals and the application of a quantitative survey that aims to inform future political decision making for climate change adaptation.



Findings: Our findings highlight the need for adaptation research to become more reflective and practice-orientated in order to foster greater stakeholder engagement with adaptation and adaptive capacity building. The study suggest that future adaptation research should allow scientists and stakeholders to co-produce knowledge in an interactive setting and to jointly develop research questions. This requires adaptation research to be conducted in a conducive environment, where scientists and stakeholders spend enough time to co-evaluate research results, learn from each other, assess adaptation needs and build mutual trust. Moreover, science-stakeholder driven adaptation research further needs to acknowledge social barriers to adaptation, including factors affecting perception of the severity of climate change risks and the efficacy of adaptation measures. Moreover it needs to develop user orientated climate change communication strategies that build upon insights into these barriers and that convey a sense of agency among stakeholders.

Significance for practical solutions: Our multidisciplinary methodology provides important lessons for future, demand-driven approaches to climate services in Europe and elsewhere. It offers methodological insights into the production, tailoring, translation and transfer of climate information, ensuring that the best available decision-relevant science is effectively communicated and easily accessed by stakeholders. It will also help develop policies and evaluate mitigation and adaptation strategies and help building the necessary skills and capacity of different user groups in applying this information in order to reduce climate-related losses and enhance benefits.

ABSSUB-1405

The Vulnerability, Impacts, Adaptation, and Climate Services Advisory Board (VIACS AB) for CMIP6

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Research question: Climate change adaptation relies on a foundation of science that extends from complex physical models of the climate system into sectoral impacts and climate services to support specific decisions. Communication has long been a challenge between the various communities involved, including climate modellers, the array of researchers who utilize climate model outputs to study sectoral impacts, and the spectrum of climate service experts. Bridging the gap between these groups is vital to improving future plans related to adaptation, mitigation, and policy planning around the world. It is critical that output and analysis requests work their way from the applications communities back to the modellers, and likewise that modellers are able to communicate key assumptions and caveats to warn of applications that may be on shaky ground.

Methodology: In its latest iteration, the Coupled Model Intercomparison Project (CMIP6) endorsed a new effort to facilitate two-way interactions between climate modellers and climate model applications experts. The VIACS AB was formed to enable more fruitful dialogue between leading climate modelling centres and major sectoral leaders (e.g., water resources, agriculture, health, urban, ecosystems, forestry, fisheries, transportation), climate service agencies, international projects and programmes (e.g., ISI-MIP, AgMIP, TGICA, CORDEX, WGRC), and regional experts applying climate model output around the world. The VIACS AB regularly interacts CMIP leadership in order to field requests from the climate modelling community, survey their respective communities, and return composite answers and questions of their own for CMIP modellers. The VIACS AB is anchored in PROVIA in order to provide long-term stability and continuity.



Findings: As its first activity, the VIACS AB solicited applications community feedback to identify priority variables and MIP experiments for CMIP6. As different VIACS groups have different variable needs, it was not reasonable to create a single priority list that represents the demand of the entire community, but some common variable priorities emerged. A similar pattern can be found for the MIP experiments: nearly all groups are requesting the historical simulations and simulations of the RCPs, while additional requests are a mixture of priorities depending on the sector.

Significance for practical solutions: The VIACS AB has successfully created points of contact within key impacts sectors, climate services, and climate modellers; and encourages members of all communities to utilize its position to raise important issues. In particular, if stakeholders or experts assisting in solution making do not feel that the climate or impacts sectors modellers are providing the information required for decision making, they can raise their concerns or requests with the VIACS AB. Through this process we can help CMIP6 to potentially produce the requested output, visualization, or information to help build a more resilient future.

ABSSUB-946

Global climate risk management – Introduction to ICA-RUS report 2015

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Research question: 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. This also matters for near/mid-term adaptation policies.

Methodology: We have tackled this issue from a risk management perspective in an interdisciplinary research project, called ICA-RUS. It has tried to integrate insights from the areas of climate risk assessment, energy economics modelling, energy-water-food-ecosystem nexus, and STS (science, technology and society). We have supposed three “Alternatives left to humanity” represented by mitigation targets, 1.5 (T15S30), 2.0 (T20S30) and 2.5 (T25S30) °C, below which humanity tries to keep the global mean temperature increase relative to preindustrial levels at a probability of 50%. For each alternative mitigation target, potential consequences have been assessed for various sectors including disastrous weather events, water resources, agriculture, health, ecosystem and tipping elements. The potential consequences are represented by a range taking into account uncertainties in climate, mitigation and socio-economics. 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 modelling assumptions.

Findings: Reduction in action cost generally tended to appear more sensitive than increase in impact risk to the easing of the target from T20S30 to T25S30. Thus from the point of view of global economic rationality, T25S30 may result in less economic loss than T20S30. It is necessary to note, however, that this will not become apparent in the real world unless climate risks, spillover risks of responses, co-benefits, and so on are all converted to economic value so that the costs of actions can be comprehensively compared. As far as tipping elements are concerned, more careful discussion is required. If, for example, the tipping point for destabilization of the Greenland ice sheet is assumed to be around 2°C, then it becomes more likely that the tipping point will be exceeded under T25S30 than under T20S30. If the economic loss due to the start of



destabilization of the Greenland ice sheet were to be included and the impact damage of this were to be comparable with the difference in cost of action between T2S30 and T20S30, then T25S30 might not be justifiable from the point of view of global economic rationality.

Significance for practical solutions: According to the analyses, we could also indicate sectors and regions where large negative impacts are remained even if the 2°C target is achieved. Prioritized consideration of adaptation in those sectors and regions would be a robust policy suggestion.

ABSSUB-778

An assessment of the adaptation scenarios for the Croatian coast

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Research question: Coastal flooding is currently one of the major threats to coastal livelihoods and infrastructure around the world and flood risk is expected to increase significantly due to sea-level rise. While there has been a lot of interest in global scale assessments of adaptation to increasing levels of such risks through protection with dikes, a country-scale analysis that includes other possible responses such as retreating from the coast are few in the literature. This is a major limitation for finding practical solutions to increasing coastal flood risk, which need to consider diverse options within the national policy context taking into account socio-ecological details at local level.

Methodology: This paper addresses this gap. We present a national assessment of adaptation to coastal flood risk for Croatia. The study is based on a new flooding model developed within the DIVA coastal impact framework. The model assesses trade-offs and combined effects of coastal protection via dikes and retreat via establishing setback zones, which has, to our knowledge, not been done before. Protection is assessed based on maintaining and upgrading dikes. Following the national policy context, setback zones are modelled as specified by the Mediterranean ICZM Protocol, ratified by Croatia. It requires the establishment of a 100 meter setback zone in Mediterranean coastal areas. We address the question of how setback zones can be best combined with protection via dikes. The initial capital stock in the entire coastal zone in Croatia is estimated by valuing buildings and land using data from local tax authorities. Once a set-back zone is established, we assume an exponentially decaying capital stock and projected increases in the stock through investment. Various combinations of adaptation options are evaluated in terms of the expected number of people flooded, expected cost of flood damage and land loss and the expected annual costs for dike building and maintenance.

Findings: Our preliminary findings suggest that urban areas in Croatia are already facing high flood risks today. For densely populated areas, protection via dikes is highly cost-efficient in particular when taking into account sea-level rise. For less densely populated areas, set-back zones are an effective response, but in order to minimise costs these need to be established as soon as possible. By using different thresholds and population assumptions, we find between 32% and 88% of the coast of Croatia to be subject to protection and set-back zones are installed at the remaining coast.



Significance for practical solutions: The study is of great practical relevance; it has been co-designed and jointly implemented together with stakeholders from the Croatian government, civil society and the Mediterranean Action Plan. The study is the first of its kind in the region and has raised the awareness of the major threat of coastal flooding to Croatia. It also informs the ongoing development of a Marine and Coastal strategy for Croatia.



ABSSUB-1285

Managing water quality in the face of climate and other uncertainties

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Research question: The U.S. Environmental Protection Agency (USEPA), together with its state and local partners, develops watershed implementation plans designed to meet total maximum daily load (TMDL) water quality standards. Uncertainty regarding the impacts of climate change, future land use, the effectiveness of best management practices, and other drivers may make it difficult for these implementation plans to meet water quality goals. But the methods and processes used to develop implementation plans typically do not address uncertainty in these key drivers of change.

Methodology: This talk will examine how Robust Decision Making (RDM) methods could help USEPA and its partners develop implementation plans that are more robust to such uncertainty. RDM methods have proved broadly useful for water supply planning and have been used by organisations such as the World Bank, the US Bureau of Reclamation, and several leading water agencies in the U.S. and in other countries. But these methods have not been previously been applied to the challenge of protecting water quality under climate change. This talk will describe an application of RDM in this area.

Findings: The result will present results for a case study analysis for the Los Angeles River, where water quality is being managed as part of an integrated water management effort focused on water supply, water quality, and flood control. In addition, the jurisdictional context is complex, with state, federal, regional, and local agencies all involved in the process of setting standards, developing plans, and investing and operating infrastructure. This talk will present results of this Los Angeles case study, and compare them to previous case studies on the Patuxent River in Maryland and on the North Farm Creek tributary of the Illinois River, both regions with different hydrologies and different integrated water management challenges. Our findings suggest that proposed plans meet their water quality goals in under current assumptions, but do not meet water quality goals in many climate and other futures. Our findings also suggest that modified plans and adaptive management approaches can often reduce these vulnerabilities.

Significance for practical solutions: This work suggests that RDM methods can be used to address climate change in managing water quality as well as in managing water supply. In particular, the case studies suggest that regulatory agencies can manage future uncertainty by employing iterative risk management processes and adopting compliance plans that are robust and flexible. The talk will conclude by examining some of the implications of incorporating climate uncertainty analysis in a regulatory, as opposed to planning, decision context.



ABSSUB-1319

Smart use of flood-risk management resources starts with a flood risk vision

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Research question: The concept of Multiple Layer Safety can be used to select measures for prevention, spatial planning and crisis management to reduce flood risk. Using cost-benefit analysis as the primary way to direct flood-risk management usually results in allocation of resources and budgets to preventive measures. Case studies about the implementation of multi-layer safety show that spatial planning measures are relatively costly compared to their flood-risk reduction. At this moment implementation of impact reducing measures is more or less ad hoc and randomly, instead of based on a coherent policy plan or boundary conditions. Our research focuses on the assumption that a more efficient of resources is possible if the multi-layer safety strategy is no longer applied on the level of local projects.

Methodology: Defining a 'flood risk vision' could be a first step to reduce risk with less resources (even though it might not be economically optimal), in less time to get things done. This vision can be part of all kind of planning or policy documents. This vision contains choices where and where not to reduce risks and how. In a case study we compared (1) a reference situation, which is the current policy practice, with (2) a situation with a flood risk vision on a local scale (for example a reconstruction area) and (3) a situation with a flood risk vision on regional scale, defined as the area in which the risk can be influenced by all layers. In the case study we took into account a longer period than usually in spatial planning. We assessed three parameters: flood risk, time spent by authorities and costs/investments. The results have been discussed in expert meetings.

Findings: The research shows that with a flood risk vision a more efficient of resources is possible when boundary conditions are defined on a level on which prevention, spatial planning and crisis management can be influenced. The benefits of a translation of this vision into design criteria for local projects and spatial developments are twofold: time of local policy makers and available budget. Currently predefined project-based budgets are leading in spatial development. Design criteria in the flood risk vision enable a more efficient use of resources. This also means time saving for authorities in planning and development. Experts recommend updating the flood risk vision once in 12 years, synchronized with national politic flood risk accountability. A negative implication of the flood risk vision is that local policy makers might feel uneasy in formulating specific requirements and allocating budgets for risk-reduction measures in selected areas. This might reduce their freedom for future developments. However, the need of flood risk vision for long term spatial planning and development will always be a political decision.

Significance for practical solutions: The research was limited to a fictional case. As a next step the flood risk vision and can be developed for a real area. This research has been funded by STOWA.



ABSSUB-380

The potential uses of climate analogues for awareness-raising and urban climate adaptation

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Research question: Despite scientific consensus about growing climatic threats and impacts, the majority of European cities has not yet implemented climate adaptation plans. Such paucity of political involvement can be associated with a lack of understanding from both civil society and decision-makers. This emphasizes the need for innovative methods and tools that bridge the gap between science and decision-making. The climate analogues concept, devised to link the future climate of a city with the current climate of a different one, contributes to answer this need. This study explores how and to which extent this approach can be applied to European cities and be used as both communication and decision support tools.

Methodology: Climate analogues are investigated by a newly-developed matching method, suitable to link European cities' future and current climates as well as to determine the European cities climate change through the 21st century. This implies the use of many climate statistics of temperature, precipitation, snow and wind speed, derived from a number of regional climate models projections, under different IPCC-SRES emission scenarios.

Findings: Using this approach, we led the first large-scale investigation of climate analogues in Europe, matching not less than seventy twins, for which the future (2070-2100) climate of a city 'A' (e.g. Hamburg, Germany) will be significantly similar to the current climate of a city 'B' (e.g. Toulouse, France). Moreover, we evaluated the geographical shift of these cities' climate across Europe, from 1950-1980 to 2070-2100. Details of how climate analogues can be used to raise public awareness about the forthcoming impacts of a changing climate where people live are presented. We propose a user-friendly and versatile tool that allows a rapid visualization of the location of any European cities' future climate, so that the user intuitively envisions the main changes – in terms of climatic conditions – that the city will face at the end of the 21st century. Furthermore, by visualizing the climate shift of a city from 1950 to 2100, one can also readily grasp the extent and the speed of change.

Significance for practical solutions: A second potential use of climate analogues, which is to serve as a decision support tool for climate adaptation in cities, targeting urban stakeholders and decision-makers, is also presented. Based on the fact that the future climate of a city 'A' and the current climate of a city 'B' are significantly similar – particularly in terms of their thermal regimes –, and through a comparative analysis of these two analogues, stakeholders from a city 'A' may immediately envision impacts to be expected from a changing climate, as well as easily identify adaptation measures, strategies and best practices. The latter could be achieved through knowledge sharing, in various fields, both at political and infrastructural level. Practical applications of this innovative use of climate analogues are presented through several case-studies involving many cities' analogues.



ABSSUB-1453

A framework for evaluating and comparing climate change adaptation in US cities

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Research question: Many academics, governments, and non-governmental agencies are striving for increased adaptation to climate change so that human and natural systems are prepared for its effects. Currently, more than 80% of the US population (and more than 50% worldwide) live in urban areas, making urban adaptation particularly important.

Many frameworks exist to measure vulnerability to the changing climate at the city level. However, the current literature lacks assessment of cities' capacity to take on adaptation action and to reduce losses and damages arising from climate hazards. This work aims to advance the knowledge of adaptation by exploring the connection between adaptive capacities and the impacts of climate disasters. By building a forward-looking framework to assess the vulnerability and adaptive capacity for five US cities (Baltimore, Davenport, Los Angeles, Memphis, and Seattle), this paper presents analysis of each city and comparisons among them to demonstrate the utility of the framework for national and international use.

Methodology: The framework for the assessment consists of two main components. The first measures the climate impacts on urban lives and livelihoods indicative of the degree to which an area is unable to cope with four primary hazards (extreme cold, drought, flooding, and heat). This is measured in terms of exposure (potential occurrence of a biophysical event, trend or impact) and sensitivity (the extent to which an urban area will be affected) to the climate hazards. The second component is adaptive capacity, or capacities specifically built through the awareness of future climate change and general features of urban areas enabling policy change and action to lessen impacts.

The assessment's indicators are expected to have explanatory power on why urban areas have experienced a certain level of adverse impacts from historical climate hazards. A selection model was built to look for those indicators that co-vary with "outcome indicators" such as number of fatalities, injuries and property damage. These outcome indicators are to be aggregated into an overall score representing the effect on lives and another score for the effect on livelihoods, thereby allowing for comparisons among urban areas experiencing different hazards.

Findings: Our preliminary analysis shows the following urban area characteristics contributing to adverse impacts from historical climate hazards: informal settlement, proportion of vulnerable populations, average age of city buildings, diversification of energy sources, population dependent on food aid, population in poverty, household average income and government cash flows from outside of the city.

Significance for practical solutions: These assessments can be used by government, non-profit and business leaders to inform market and policy positions that improve livelihoods and save lives. The project goal is to inform influencers so that stakeholders and investors build social, physical, and natural systems that are adaptable to the impacts of climate change.



ABSSUB-950

Integrated approaches to analysis and deliberation in community climate risk management

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Research question: How can we simultaneously address political barriers to climate change adaptation and technical and scientific requirements? Building resilience and supporting sustainable development in the face of climate presents a host of “wicked problems” in which there is no definitive formulation of the problem, information is confusing and contradictory, and the planner has no right to be wrong. A result, is there is often significant disagreement around how to characterise climate risks, in terms of how they should be weighted in accordance with other risks and social priorities, often leading to inaction.

Methodology: This presentation synthesizes insights from practice into a framework for risk management in democratic societies. The framework (Norton 2006) aims at pragmatically combining scientific models and stakeholder mental models in a transdisciplinary process that emphasizes building accountability, effective communication, and trust. It draws heavily from work of the U.S. National Research Council (NRC) on the subject which emphasizes inclusive and broad deliberation along with analysis in a process that will ensure the risk managers base their decision on an informed consensus.

Findings: This presentation shows how the NRC’s work can be more systematically understood and applied through approaches emphasizing information and communication tools varying from simple GIS maps, to role playing games, to integrated simulations (Pahl-Wostl 2007, Barreteau 2007). These approaches already have significant and growing communities of practice and bodies of documented case work in Europe, Southeast Asia, Africa, and Latin America.

Significance for practical solutions: By highlighting and showing their significance in light of the NRC’s recommendations, the presentation shows how increasing the use of these approaches can help communities overcome political barriers to climate change adaptation.

ABSSUB-958

A way forward for mainstreaming measures for flood resilience in development projects

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Research question: Many cities are adopting a resilience approach to cope with flooding. Such an approach is adaptive to acute shocks, gradual trends and climate variability and considers flood management objectives as an integral part of the liveability of public space and buildings. Mainstreaming is considered as an



important means to implement resilience approaches to flood management. It stands for an opportunistic approach that uses planned and ongoing developments to couple flood management objectives with other objectives to achieve synergistic effects, such as cost savings or societal benefits. Thus far, research focusing on mainstreaming adaptation has been more policy-oriented than projects-oriented. Accordingly, systematic analysis of how opportunities from planned and ongoing projects can be used is missing.

Methodology: Here, we present the outcomes of a feasibility assessment that was conducted for three potential mainstreaming opportunities to realise flood risk management measures on the Island of Dordrecht in the Netherlands: 1) reconstruction of a regional road that potentially could be upgraded towards an access/evacuation route during flooding; 2) large maintenance works of a local road that potentially could be upgraded towards a 'life-line' for a large unembanked residential area during times of flood; and 3) an ecological restoration project that provides an opportunity to realise an eco-passage through the existing secondary dike that can also divert flooding away from the urbanised part of the Island. The feasibility of each of these potential opportunities was systematically assessed through an qualitative analysis of the added value of the opportunity, practical constraints (time, legal, interdependencies), financing possibilities, requirements from maintenance and operation and contractual requirements.

Findings: For each of the cases it was concluded that utilising the opportunity is currently is not feasible. Utilising the mainstreaming opportunities would for none of the cases be free of cost, whilst it was at the time of analysis no funding source readily available to cover these. The case of the reconstruction of the regional road showed that in the Netherlands the institutional responsibility, and thus funding capacity, for evacuation infrastructure is lacking. Furthermore, in case of the ecological restoration project it was concluded that there is no or limited added value in using the opportunity apparently available and it would be easier from a project management point of view to separate the projects rather than trying to synchronise them.

Significance for practical solutions: We conclude that, despite the ambitions of policy makers, it is not straight-forward to utilise mainstreaming opportunities in projects. Our cases illustrate that mainstreaming involves: harmonising policy objectives (strategic), synchronising investment agendas (tactical), alignment of stakes in projects (operational). Particularly the latter two aspects are currently overlooked.

ABSSUB-989

Migration as adaptation to climate change in Mahanadi Delta

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Research question: This study, as a part of the on-going DECCMA (DEltas, vulnerability and Climate Change: Migration and Adaptation) project, attempts to answer the research questions: 1. can the risks promote migration and its outcomes? 2. what are the different characteristics of male and female migrants? 3. what are the reasons for migration? 4. what kind of the challenges women face in coping with the new environment and communities?

Methodology: The study of migration in the context of climate change has been attempted using the concept of risk, represented as probability of occurrence of hazardous events multiplied by the impacts in the IPCC AR5, WGII, 2014 framework and migration analysis using the indirect methods- vital statistics and census survival ratio. Risk assessment has been proven to be a useful tool to identify, quantify, and rank the climate



change hotspots in the Mahanadi Delta and examines the complex interactions between diverse components of the natural system along with human interventions.

Findings: From the sub-district level (block) risk and migration analysis, it has been observed that several coastal blocks adversely affected by climate change and low level of economic growth exhibit higher risk and high rate of out-migration. Dhamnagar, Ersama, Balikuda, Tihidi, Chandabali blocks are bio-physically and socio-economically at very high risk where out migration dominates. On the other hand, several blocks of comparatively lower risk like Khordha, Puri districts or other urban growth centres show positive net migration or in- migration. Apart from the inter-district migration, the migrants also travel to other states like Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, and Gujarat every year to work in the constructions industry, transportation sector and others.

Climate change impacts on the natural resource based economy owing to which agriculture and fishery are increasingly becoming unprofitable for the community. The large scale labour migration is attributed to the absence of alternate livelihood options in this delta. Studies indicate that in the immediate aftermath of the devastating cyclones of 1999 and 2013, labour migration increased manifold in the coastal region. The present research discusses whether migration can be considered as an adaptation option when the mainstay of livelihood, i.e. agriculture is threatened by repeated flooding, sea level rise, cyclone and storm surges, salinization of soil and crop failure due to temperature stress imposed by climate change. It is expected that, in the future, there will be an increase in the trend of migration in Mahanadi Delta which can be analysed in response to various climatic and non-climatic stresses.

Significance for practical solutions: The study identifies causal, temporal, and spatial dimensions of migration, and their correlations with climate change impact to enable the development of an appropriate adaptation policy framework for the delta.

ABSSUB-1381

Current adaptation and planning priorities at the district level: Volta delta case study

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Research question: Communities in the low-lying areas of the Volta delta of Ghana have had to develop strategies to manage impacts of a combination of factors, including increasing degradation of natural resources due to an expanding population and poor management practices, ecological changes due to the construction of the upstream Akosombo and Kpong dams, floods and droughts from unpredictable rainfall patterns, and coastal erosion and floods from increasing sea level rise. In addition to spontaneous responses by local communities, a number of planned institutional programmes have provided community-based and large scale infrastructural strategies to minimise these impacts. For ten districts located in the deltaic zone, the study identifies and prioritizes key non-climatic and climatic factors affecting communities and the significant formal and informal processes that have enabled communities to respond.

Methodology: Using a participatory process with a wide range of stakeholders from each of the ten districts,



including traditional leaders, governmental and non-governmental organisations and community leaders, key driving climatic and non-climatic factors and responses at the district level are defined and scored, with various supporting formal and informal processes explored and prioritized.

Findings: The findings of the study show that (i) stakeholders consider ecological and developmental factors as key drivers of the adaptation process at all scales, with little consideration for climate change and variability, (ii) adaptation planning is significantly defined by the district's developmental level and contribution to national economy, such that there are differential pathways for responding at both community and district scales, and (iii) there are various actors and informal processes that significantly influence adaptation responses, and must be taken into consideration when planning within the districts.

Significance for practical solutions: The National Climate Change Policy, implemented in 2014, has prioritized national programmes between 2015 and 2020 for supporting adaptation processes in vulnerable ecological zones such as the low lying coastal zones. The findings from this study clearly define priorities of the district and significant planning processes that can enable the districts to align with and obtain support for mainstreaming adaptation processes being implemented at the national level.

ABSSUB-1161

Climate change adaptation in small and medium-sized cities: an example from the Czech Republic

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Research question: The main objectives of our research were: (i) to identify climate change-driven threats in three pilot cities of different sizes; (ii) to analyse a state of climate change adaptations incorporated in existing politics and plans of studied cities; (iii) to find out if these correspond to expected climate change-related threats they are facing and help with optimization; (iv) to support policymakers in a more adaptive future development within the cities that would put a greater emphasis on climate change related risks and offer solid options for urban adaptations.

Methodology: In three pilot cities (Dobruška, Žďár nad Sázavou, Hradec Králové), we used two sets of participatory workshops and public interviews and we identified the main climate change related threats for each of the cities. The workshops involved a range of stakeholders from different sectors of public administration and key institutions.

Findings: It emerged that studied cities are (at least partly) prepared for existing threats such as floods, but not yet prepared for regionally 'new' climate change-related threats such as droughts and heat waves. Public interviews showed, that despite the fact that majority of people experienced a climate-related disaster they do not feel endangered by climate change.

Significance for practical solutions: All obtained results were used to formulate and analyse needs, limitations and opportunities for future development which will, in optimal cases, lead to the creation and implementation of adaptation strategies. In respect to a mixed nature of the outcome from workshops we made both, quantitative and qualitative analysis. Besides that we developed strategies for future adaptations based on spatially explicit matching of threads and adaptations. Obtained results and experiences gained from pilot studies should help in creation of a versatile 'road map' to adaptation in the



regional physical-geographical and social-economical setting of small to medium sized cities in the Czech Republic.

ABSSUB-896

Comprehensive impact assessment and adaptation measures based on new scenarios in Japan

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Research question: Climate change impacts have been becoming obvious all over the world. In Japan, many urban areas, mountainous settlements and remote islands are suffering from torrential rain and landslide damage every year on a scale not previously experienced. Moreover, various impacts of climate change are becoming apparent in fields such as water resources, ecosystem, agriculture, coastal areas and health. To prevent risks of harm brought by climate change from growing out of control, we need to achieve a significant reduction of global greenhouse gas emissions during the 21st century. However, the current outlook of international negotiations is far from clear. Even if the global community devotes its maximum effort and manages to curb rises in global temperatures within 2 degree of the pre-industrial level, we will not be able to avoid experiencing increases in damaging impacts of extreme weather events. Adaptation measures are designed to prepare for these negative impacts, of which we must step up the planning and implementation. In addition, we anticipate that the Japanese society will be largely influenced by factors such as a declining birth-rate and aging population, globalization of industry, natural disasters and others. Combined with these changes, we project that climate change will bring multiple impacts to us. How we handle the impacts of climate change is believed to be an important factor in future social and corporate activities, and designing individual and household living. Our research aims to reveal the risk of potential impacts to Japan and the effectiveness of measures designed to reduce the risks.

Methodology: We conducted comprehensive impact assessment considering with/without adaptation measures nationwide under four RCPs such as RCP2.6, 4.5, 6.0 and 8.5 using multi CMIP5 climate scenarios. Quantitatively assessed indicators of adaptation effect are flood damage, landslide, *Fagus crenata* potential habitat, rice yield, and heat stress excess mortality utilizing detailed impacts assessment models with 1km mesh spatial resolution. Base period (1981-2000) and two future periods (mid-21st century: 2031-2050, end of the 21st century: 2081-2100) are set for targeted periods.

Findings: It is assessed that climate change exerts impacts on a variety of fields in Japan throughout 21st century. The impact of disasters related to extreme weather, health effects such as heat stress, impacts on water resources, agriculture and ecological changes, are expected to be wide in scope and extent affecting; 1) national health, safety and security, 2) national life quality and economic activity, 3) ecosystems.

Significance for practical solutions: Our results could serve as a foundation for the formulation of adaptation measures and assessment of the feasibility of realizing a safe and secure climate change adaptive society at local government in Japan.





ABSSUB-831

What constitutes transformation? Reviewing adaptation to social-ecological risks in semi-arid lands

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Research question: What makes an action 'transformational' or 'transformative?'; How does current and proposed adaptation activity in semi-arid areas relate to ideas around transformation?; What can we draw from this about what it may mean for the wellbeing different groups of people in semi-arid areas, at different spatial scales and timescales?

Methodology: The discussion draws from 4 regional literature reviews undertaken through the project Adaptation at Scale in Semi-Arid Regions (ASSAR) funded under the CARIAA initiative: relating to India, East Africa, West Africa and southern Africa. This is combined with review of the rapidly-growing pool of literature discussing ideas of transformation relating to climate change.

Findings: Response to social-ecological risks takes many forms, some of them effectively adjustments to current activities, others involve a more radical change. Review of responses in semi-arid lands provides us with an understanding of how a range of responses sit within an adaptation-development spectrum in a highly dynamic environmental and societal setting. Ultimately there may be a limit to the effectiveness of 'incremental' approaches to adaptation in semi-arid areas. Severe pressures on the water and soil resources base interacting with increasingly intensive climate change suggest there may well be a need for larger-scale systemic and/or radical changes. Transformation may become evident in various ways, including shifts in diets, food supply chains, sites of agricultural production, systems of land allocation, and incentives for linking land and water use to ecosystem service functions. Yet transformation can also be driven by social dynamics and social goals, constituting forms of societal change that challenge the structural root causes of differential vulnerability and adaptive capacity, including development pathways.

Significance for practical solutions: Transformation is a term moving rapidly into the international discourses surrounding climate change adaptation. Critical perspectives on transformation are starting to question the plurality of meanings coalescing around the term. Using the examples of semi-arid lands (which arguably are crucibles of environmental dynamics and climate change 'hotspots'), it is therefore timely to examine how the ideas of transformation correlate with practice on the ground, and what these different interpretations tell us about the prospects to embrace equitable, progressive, and widespread adaptive change.



ABSSUB-846

Risk perceptions, awareness and status quo of climate change adaptation in Austrian municipalities

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Research question: Climate change (CC) affects many socio-economic sectors and residents of communities. Adaptation to CC is therefore a key issue for several levels of decision making on municipal level. Since CC adaptation strongly depends on the adaptive capacities of socio-economic systems, problem awareness and proactive policy responses play a key role. Thus, the questions arise whether communities are aware of CC risks, how they respond to the challenges of CC, and what are their needs for implementing adaptation measures.

Methodology: In 2015, a representative online survey based on a standardised and structured questionnaire asked persons responsible for the topics of CC and CC adaptation of all Austrian communities about these topics. The survey assessed their perceived dependence and vulnerability against CC, awareness and status quo of CC adaptation in their community, their future plans and needs for support tools for the implementation of adaptation activities. The survey also asked factors which impede or encourage adaptation activities on municipal level. Several reminders were sent yielding in a response rate of 14%. Responses of 321 communities were collected, resulting in a sampling error of $\pm 5\%$.

Findings: Results show that many Austrian communities are engaged in CC mitigation, while CC adaptation is so far not a relevant topic; even one-fourth of them have never heard about the term CC adaptation. Communities active in CC mitigation are also more active in CC adaptation. About 43% have already perceived negative impacts of CC. About two-thirds are aware that CC adaptation is necessary and about one-third has already employed adaptation measures, mainly in the fields of infrastructure, traffic, energy and settlement development. Constraints in employing adaptation measures are the lack of knowledge, the rather unimportant role of CC adaptation compared to other every-day community tasks and lacking personal resources. Communities especially expressed a need for support by individual expert consultation. The individual attitudes towards CC of the respondents and active neighbourhood communities seem to be significant drivers of becoming active in CC adaptation, while negative impacts of CC on the community such as storms or droughts were not predicting whether communities are active in adaptation.

Significance for practical solutions: Building capacities for action on community level in Austria in a successful way requires the understanding of the needs, activities, and the knowledge for CC adaptation of communities. This survey also points out that attitudes towards CC of persons who are responsible for this topic seem to be a key factor whether communities are active or not. Survey data assist in building capacities to cope with CC in supporting municipalities in adaptation by developing specific training tools.



ABSSUB-869

Adaptation and the big picture: an evaluation of multi-scalar linkages and barriers in Nunavut

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Research question: We characterise and evaluate adaptation readiness in the northern Canadian territory of Nunavut to create a big picture understanding of the adaptation landscapes across scales and locations. In doing so, we ask: What are the key linkages facilitating adaptation? What interactions are occurring across multiple scales? What are the key barriers preventing adaptation from occurring and how might these be overcome as Nunavut moves forward?

Methodology: To evaluate the adaptation landscape in Nunavut, we empirically apply the Ford and King (2015) Adaptation Readiness Framework at the community, territorial and national scale and assess seven overarching factors we believe are necessary for adaptation to take place: political leadership, institutional organisation, decision-making, stakeholder engagement and public support, usable science, Inuit Qaujimajatuqangit, and funding. Key informant interviews (n=50) were conducted with various government and other important stakeholder organisations from the national, territorial and selected community levels and analysed within the framework.

Findings: The results will highlight key trends within each readiness factor - political leadership, institutional organisation, decision-making, stakeholder engagement and public support, usable science, Inuit Qaujimajatuqangit, and funding – and discuss current status, importance of and connections between factors. Additionally, we will present a multi-scalar picture of key linkages and barriers to successful adaptation, identify areas of prioritization and where adaptation is lacking and discuss status of adaptation readiness overall.

Significance for practical solutions: The information provided by this research is essential information for decision makers in the north: the northern adaptation landscape is evolving very fast, yet there is limited understanding of what is being undertaken and where, raising the possibility of research duplication and neglect of certain risks / communities. By characterising adaptation readiness, the work will identify areas where further work and assistance is needed on adaptation at multiple levels of governance. These outcomes are particularly pertinent given the increase in interest in all levels of government in adaptation, helping decision makers strategically target future adaptation policies and programming. More broadly, this project empirically tests the Ford and King (2015) Adaptation Readiness Framework and finds it to be a rigorous and practical way of measuring current preparedness to adapt, key barriers and best practices of institutions across multiple scales and locations, and recommendations on what needs to be done to move forward.



ABSSUB-788

A multi-sector-partnership in transnational risk management – challenges for the Wadden Sea Forum

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Research question: Climate change is a transnational challenge and does not stop at national borders. Future management processes require transnational perspectives. The paper addresses future climate change implications in the trilateral Wadden Sea Region, explores institutional challenges and potentials for a transnational management approach and discusses the potential for new governance arrangements. Risk management, whether of natural disasters, social grievances or economic crisis faces political, institutional and structural boundaries. Risk management requires more than just technical solutions; it is a social and political endeavour, dependent on enhanced participation of private stakeholders, responsible administrative institutions and society at large. We demonstrate the re-conceptualization of risk management as a continuous collaborative and communicative governance process within a Multi-Sector-Partnership (MSP).

Methodology: In collaboration with the Wadden Sea Forum (WSF), a transnational stakeholder forum established in 2002, we developed an integrative risk management approach eliciting their contribution to transnational risk management. In a three-step workshop series together with the members of the WSF we addressed the crucial steps of an enhanced risk management: 1) risk perception (visioning approach), 2) risk structuring (bow-tie analysis) and 3) risk management visioning (scenario development).

Findings: The project demonstrated that risk-specific impacts require risk specific management approaches. Risk awareness and risk structuring are found to be essential for proactive and collaborative risk management. Storm surge risks, for example, are widely considered to be managed successfully within public administration. This perspective, however, neglects the potential contribution of economic risk management solutions. The research furthermore identified the need for greater attention to the societal perception of risk and the potential for enhanced trilateral cooperation and learning among stakeholders. The key role of WSF as bridging organisation facilitating communication, cooperation and awareness-raising among stakeholders in risk management across the Wadden Sea Region was recognized.

Significance for practical solutions: A MSP such as the Wadden Sea Forum, established to support environmental management across national and regional boundaries, can take on a decisive role in transnational risk management. Although, lacking formal decision-making powers, the stakeholder forum can contribute to an inclusive and integrated perspective on transnational risk management. Realizing this potential however is dependent on a shared understanding of risk management as a societal process requiring more than technical solutions. This necessitates critical self-reflection on the part of the MSP and a willingness on the part of MSP stakeholders to engage in the development and implementation of collaborative, transnational solutions.



ABSSUB-1369

Non-market loss and damage evaluation

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Research question: The Warsaw International Mechanism for Loss and Damage, negotiated at the 19th Conference of the Parties of the United Nations Framework Convention on Climate Change, aims to address compensation for loss and damage in developing countries particularly vulnerable to climate change, including extreme weather and slow-onset events, and potentially irreversible conditions. Nonmarket costs associated with damage to and loss of life, health, territory, indigenous/local knowledge, displacement, cultural heritage, and biodiversity and ecosystem services are most difficult to evaluate, albeit crucial for those who are affected.

Methodology: We will be holding a workshop in early 2016 that brings together a group of scholars with diverse backgrounds to address the epistemological and methodological challenges associated with non-market valuation of loss and damage under climate change. Drawing from insights in environmental economics, philosophy, geography, health sciences, anthropology, resource management, social work, demography, and social justice, our team will assess existing approaches to non-market valuation. We will experiment with novel lenses to identify what different stakeholders may value, across space and time, and what they are likely to experience as loss, now and in the future, as individuals, society, and in the environment.

Findings: We expect the study to provide insights into ways of "measuring" the non-market aspects of loss and damage. We will reporting on how these approaches apply for specific climate change impacts, discuss needed data and knowledge deficits, and outline a framework for non-market loss & damage assessments with direct relevance for the UNFCCC, addressing both urban and rural contexts and outlining applications in Australia, Ghana, South Africa, and India.

Significance for practical solutions: Results of the study should provide new ways of thinking about loss and damage from a non-economic perspective. It will be of use to a wide range of practitioners and researchers working in this emerging field, and will also feed back into the UNFCCC negotiations on loss and damage.



ABSSUB-819

Assessing the institutional constraints to adaptation through social network analysis in Tabasco (MX)

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Research question: Traditional frameworks to conceptualise and assess adaptive capacity have mostly focused on the physical assets endowment and economic conditions of nations or groups, largely using economic resources, poverty and equity as proxy indicators. The institutional dimension of adaptive capacity, instead, has been less explored as a result of the emphasis placed by vulnerability research on quantitative indicators. However, studying adaptive capacity from an institutional perspective is essential not only for carrying out several steps of the adaptation process, but also to identify potential barriers or constraints to adaptation.

Methodology: By taking the state of Tabasco (Mexico) as a case study, and focusing in particular on the vulnerable Carmen-Pajonal-Machona (CPM) lagoon system, we draw attention to a specific element which could constrain the effective deployment of adaptation interventions: the (poor) level of cooperation i) among the formal institutions operating at the local level on Natural Resource Management (NRM) and Climate Change Adaptation/Disaster Risk Reduction (CCA/DRR) issues, and ii) between institutions and local communities. We assess the strength of the existing links among organisations (public entities, Universities and NGOs) through a Social Network Analysis (SNA), performed with the NodeXL tool. As a complement to the SNA, we explore the networks tying formal institutions and communities employing the concept of social capital and, in particular, that of trust.

Findings: Our main results include: i) the detection of a highly sectoral approach in delivering CCA interventions, which fails to give full consideration to the critical social development needs of the area, and ii) the recognition of the deep mistrust of local communities in formal institutions as a major constraint in enhancing their adaptive capacity.

Significance for practical solutions: We provide insights to strengthen the adaptive capacity of institutions in Tabasco, so to support them in turning potential into actual adaptation outcomes. In particular, we call for: i) a deeper integration of the social and environmental dimensions of interventions to be undertaken in the CPM site; ii) fostering mutual understanding and legitimation by enhancing the participation of local communities in the decisional process, for example by means of joint workshop between formal and community actors (a practice which is often disregarded in Tabasco); iii) enhancing the capacity of the most vulnerable sectors of the society, drawing particular attention on women and at their role as active economic agents, not just as victim of violence and discrimination; iv) Exploring the potential of non-conventional actors, like Churches and religious entities, to convey information and virtuous behaviours related to NRM and DRR/CCA.



ABSSUB-895

Improving social-ecological governance in Atlantic Canada communities to adapt to climate change

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Research question: Coastal rural communities worldwide have to face many challenges not only related to climate change but also extreme events, environmental degradation, population growth, and conflict usage of the ecosystem. Historically, the economies of coastal rural communities have been based on the exploitation of natural resources, which has structured its territorial development. Such a development has led to some limitations in the way these communities can now adapt to climate change. For example, the country's level of development and economic wealth can have an impact on the capacity of rural communities to develop new activities that can help them to adapt to climate change while ensuring their sustainability. Several projects have attempted to define the adaptation strategies in order to enhance the sustainability of these communities. Most previous adaptations have been based on technical solutions or policies that deal with the physical infrastructure. However, several issues such as governance, community involvement, and social equity, should be integrated into any action to help communities enhance their capacities to adapt. The question that we have examined is how to enhance the social-ecological dimension of adaptation in coastal communities through improved governance and the understanding of the ecosystem.

Methodology: This project was a longitudinal study with multiple study sites (ten communities) that are located in the Estuary and the Gulf of St Lawrence, in Canada. Several activities at the community level were completed over a period of four years to enhance adaptive capacity through enhancing knowledge and governance, and co-produce tools that communities can use to improve their adaptation to climate change.

Findings: The results showed that using a social-ecological approach and integrating the importance of ecosystem services and social-cultural aspects, communities can better understand the issues and address vulnerabilities. Several tools were developed such as building adaptation strategies from learning about vulnerabilities, social network analysis, and monitoring effectiveness of actions. These communities have adopted these tools and enhanced their own capacity to deal with adaptation. Challenges still exist where financial support does not exist or policies are too difficult to change.

Significance for practical solutions: The tools are now in the process to be transferred and some of them have already been adopted by other communities of Atlantic Canada. Some of these tools will be presented in this presentation. The consequences of this project were to empower communities to start discussing adaptive capacity, issues of governance and how they can start planning for the future. This was extremely important considering their aging population, limited level of education and their strong reliance on natural resources.



ABSSUB-865

Social services in five Nordic countries in times of disaster

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Research question: The Nordic countries are known worldwide for their extensive welfare systems often referred to as the Nordic or Scandinavian welfare model. There is a growing literature about the importance of local social services in times of disaster. The paper asks if and how the local social services are part of the emergency planning in the five Nordic countries, Denmark, Finland, Iceland, Norway and Sweden.

Methodology: First the paper provides state of the art on the issue providing an overview of the literature about the role of social services. The legal obligations of the emergency and social services are examined in order to provide the necessary data for the policy analysis conducted.

Findings: The main characteristics of the services are examined in order to provide picture of the institutional organisation in each country. Finally the models of social services in times of disaster for each country are compared in order to reveal if there is a Nordic Model of Social Services in times of disaster or if the countries have taken different paths regarding the policies on the role of social services in times of disasters.

Significance for practical solutions: Local social services are an important component of the Nordic welfare systems, and their role is to ensure the inhabitants with basic recourses, benefits, housing and services in times of need. Social risks and vulnerability, critical dependencies and threats to vulnerable people have always been part of the field of knowledge of social work and it has been stated that the focus on vulnerability puts social work into the essence of disaster work. Thus, questions on crises and disasters are of vital relevance to social work and the distribution of risks as they reflect the underlying pattern of vulnerabilities.

ABSSUB-1117

Adaptation planning and the use of climate projections in local government in England and Germany

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Research question: Planning for adaptation to climate change is often regarded to be a local imperative and considered to be more effective if grounded on a solid evidence base and recognisant of relevant climate projections. Research has already documented some of the challenges of making climate information usable in decision-making but has not yet sufficiently reflected on the role of the wider institutional and regulatory context. The central research question for this paper is 'To what extent does the wider (political, legal and regulatory) context within which local adaptation planning is placed influence the use of climate projections at the local level in Germany and England?'



Methodology: The paper is based on a qualitative analysis of 44 planning and climate change (adaptation) documents published by local governments and on 54 semi-structured interviews with adaptation practitioners in North Rhine Westphalia in Germany and the South East and East Midlands regions of England conducted between July 2013 and May 2014.

Findings: We show that there is little demand for climate projections in local adaptation planning in either country due to existing policy, legal and regulatory frameworks. Local government in England has not only experienced a decline in use of climate projections, but also the waning of the climate change adaptation agenda more widely, amidst changes in the planning and regulatory framework and severe budget cuts. In Germany, spatial planning makes substantial use of past and present climate data but the strictly regulated nature of planning prevents the use of climate projections, due to their inherent uncertainties.

Significance for practical solutions: Findings from the two countries highlight that if we are to better understand the usability of climate projections, we need to be more aware of the external institutional context within which planning decisions are made. Otherwise boundary organisations or climate service providers run the risk of continuing to provide tools and information that are of little use within their intended context.

ABSSUB-775

From a typology of adaptation strategy to adaptation pathways

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Research question: Since the 2000s, adaptation appears slowly and discreetly among local public policies on French territories. Since 2007, French local authorities legally have to elaborate adaptation measures. All authorities larger than 50,000 inhabitants are legally bound to develop local climate change adaptation strategies and action plans. Therefore, local decision makers and technicians are at the forefront of adaptation. Yet, this top-down injunction leads to many challenges for local authorities. Among the different pitfalls, the difficulty is that climate change is highly intricate with many other issues at stake (demography, urban sprawl and urban planning, territorial development, local economy, etc.). Methodologically and politically, it is challenging for decision makers to "operationalize" adaptation, because, among others, adaptation is mainly a theoretical concept tinted with a semantic blur. Despite this, different types of measures are designed and even if the implementation of actions is fairly limited, some experimentations materialize and adaptation undergoes maturation. If we consider adaptation as a "process of adjustment to actual or expected climate and its effects" and aiming at "moderating or avoiding harm and exploiting benefice" (AR5 GIEC, 2013), what does adaptation mean? Adjustment of what (territories, populations, communities, local economies, etc.) to what (climate change, global change)?

In order to give more sense to this concept of adaptation, to facilitate its appropriation by decision makers and its operationalization by technicians, we propose a typology of adaptation measures and of adaptive rationality.

Methodology: In order to give more sense to this concept of adaptation, to facilitate its appropriation by decision makers and its operationalization by technicians, we propose a typology of adaptation measures and of adaptive rationality. We have reviewed local actions and strategic plans related to climate but also to urban planning and water management on and the eastern coastal area of Languedoc Roussillon in the south



of France. The analysis of these planning documents is based on Anderies robustness framework (Anderies et al., 2004) to describe the social ecological system, and is enriched by semi-structured interviews. Existing conceptual developments on adaptation (Berkes et al., 2003; Pilifosa et al., 2007) are tested and improved to fit these specific policy frames.

Findings: We analyse the types of action (technical, cognitive, regulatory), associated aim behind (raise limiting factors, create a new awareness, etc), and their potential effects (positive, negative). Throughout this effort to build a typology, we try to highlight the "adaptive rationality" but also motivations, logics and instruments of adaptation actions.

Significance for practical solutions: It can help policy makers at various organisational levels to frame adaptation and adaptation pathways and address the trade-offs held by adaptation choices.

ABSSUB-1175

Climate change mitigation and adaptation: perceptions, planning and action at the municipal level

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Research question: As many other regions in the world, Portugal needs to prepare for future climatic changes. The country faces highly adverse climate integrated impacts, from rising sea levels to heat waves, flooding and droughts, while European reports show Portugal has currently low levels of adaptive capacity. Against this background, it is central to understand how mitigation and adaptation policies, strategies and action-plans are being developed at the local level.

Methodology: To produce a diagnosis of the current landscape of CC municipal policies and actions across the Mainland and Islands, a survey has been applied to a representative sample from a total of 308 municipalities, and 67 valid responses were collected. The survey was sent online, yet most municipalities were directly contacted by phone, in order to assure the most informed person would respond. The following sample criteria were used: region (Nuts II), political party and the dimension of the municipality (number of inhabitants). These criteria were complemented by the involvement of municipalities in the covenant of mayors initiative, and its location in either littoral or interior regions (80% of Portuguese municipalities are located in coastal regions).

Findings: Results show 70, 6% of municipalities do not have any kind of plan, strategy or action; 15, 6% claimed to be developing a plan, and only 10,1% had a plan. Finally, 3, 7% were integrating mitigation and adaptation actions in order plans (e.g. the Agenda 21 programme). Overall, there is a greater focus on mitigation, in detriment of adaptation. Adaptation is claimed to require a long-term perspective, while mitigation is perceived as short/medium term action that is being promoted by international agendas. The main drivers referred for designing programmes and strategies to tackle climate change have been "fear for future impacts" and "awareness of the need for action". Values varied considerable according to North-South and Littoral-Interior axis. When asked about the weight of a set of factors for the political decision to act on climate change, the highest means attributed were "security and risk reduction" and "municipal political will". Civil society and local communities still play a minor role; and social actors (e.g. local residents, business



owners) are little involved.

Significance for practical solutions: It is concluded that although a growing interest in climate action is manifested by the respondents, CC is not a central issue for Portuguese municipalities. Availability of information and resources is important, and interest on the issue grows as information and resources increase. Richer municipalities (not the most vulnerable) are more prone to developing or to have a plan, which is typically based on the European and National Strategies for climate change. Given these findings scientific research, participatory approaches and capacity building strategies may play a central role in igniting and supporting the development of more climate resilient cities in Portugal.

ABSSUB-1273

Is scientific knowledge used for the implementation of sectoral adaptation policies in Europe?

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Research question: As the number of European countries that attempt to address the challenges of climate change through national adaptation policies is growing, so is the demand for the provision of relevant scientific and technical information. The influence that knowledge may have on policy decisions, however, has been for a long time a topic of debate in different fields. Literature presents a nexus of opinions; at the one end being the scholars who underline the potential of scientific knowledge to improve policy-making, presuming a direct and linear use of existing information, while at the other end being those scholars who challenge this assumption, arguing for the 'little effect' that knowledge often has on policy decisions. Robust scientific evidence undoubtedly provides the knowledge base required for the development of sound policies. A range of factors and their complex interlinkages, however, determine whether or not knowledge can be found, collected and finally used by policy- and decision-makers. For example, knowledge use might be constrained either consciously or unconsciously due to policy conflicts, time constraints, decision-maker characteristics, organisational structure, mismatches between the type of knowledge that is produced and needed, uncertainties etc. In the field of climate change adaptation, the role of knowledge and its use becomes of particular importance when examining the way that adaptation is implemented through its mainstreaming in sectoral policies (Objectives 2 & 3 of the EU Adaptation Strategy (2013)). Effective knowledge management is important for facilitating integration of climate adaptation goals into sectoral policy-making. For example, it provides actors with information on impacts and spill overs into other sectors around which they can coordinate their activities. In this study we examine the extent to which adaptation has been integrated in existing or forthcoming policies related to the sectors of agriculture, water management and health, in Denmark, Finland, Germany, Italy and UK.

Methodology: We used content analysis of policy documents and a set of complementary semi-structured interviews with actors working at the level of sectoral policies' implementation. The selection of countries provides a good representation of political systems, organisational structures and progress achieved in adaptation policy within Europe.



Findings: We explore the progress that has been achieved in the production and use of adaptation knowledge in each sector and country, the ways in which scientific information has been communicated to policy makers and finally the extent to which it has been used to support the implementation of relevant policies. We discuss the identified knowledge gaps and other barriers that may constrain these processes.

Significance for practical solutions: Finally, we conclude with a set of recommendations regarding the areas on which attention should be placed, if the use of scientific knowledge in support of policy implementation is to be improved.

ABSSUB-1398

Opportunities for adaptation in Central America: a view from decision makers in agriculture

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Research question: Future increase in average temperature and lower annual precipitation will have significant impacts for agriculture in the Central America. It is likely that the suitable areas for crops that support smallholder farmers are compromised in the future. The adaptive capacity of farmers will depend on the access to basic services, information, innovation resources and healthy ecosystems. Adaptation implies defining a work strategy and priorities for different areas, considering the future trends and challenges, such as sustaining the food production for the country, and current opportunities. In this work, we are interested in how decision makers in the agricultural sector from Guatemala, Honduras and Costa Rica envision the opportunities of adaptation in different areas of work and scales, and what challenges and opportunities they envision as priorities for future work that can support adaptation in agriculture.

Methodology: In order to define a framework of opportunities, challenges, and possible solutions and next steps for adaptation on the agricultural sector, we carried out workshops in Costa Rica, Guatemala and Honduras, with representatives of government dependencies, NGO's, universities, foreign aid, and research organisations. Representatives were asked to point out priority lines for adaptation in the agricultural sector in each of their countries, as well as opportunities they are aware of.

Findings: Representatives point out several lines of work and activities for adaptation, such as strengthening family and commercial agriculture, promoting adaptation within the farm, planning at the local level, strengthening local organisations, consolidation of extension services for agricultural diversification and adaptation, access to agro climatological information, access to markets, improvements in infrastructure, among others. They also defined sub-activities and key stakeholders that can be involved in these adaptation options, and identified frameworks and options that are already available at different scales.

Significance for practical solutions: This exercise of definition and prioritization of climate change adaptation actions for the agricultural sector in these countries, show that stakeholders have a clear vision on the potential impacts of climate change in agriculture, and the potential strategies for adaptation in this sector. Local priorities are found in the diffusion of good productive practices, taking into account local examples, technology and information management in an inclusive way, management efforts, and decision making. The



lines of work, activities, strengths and challenges identified by decision makers of the agricultural sector in Costa Rica, Guatemala, and Honduras, provide an opportunity for prioritization of policy options, which can help implement future changes that allow adaptation at different levels.

ABSSUB-1370

Governance to respond to climatic impacts: evaluating the Paris outcomes for policy and practice

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Research question: Responding to climate change impacts is increasingly becoming a priority for the international community. International cooperation in the policy fields of adaptation and loss & damage has been gradually advanced under the UN Framework Convention on Climate Change (UNFCCC) with an additional major milestone expected at COP 21 in Paris in December 2015. The session aims to answer the following research questions:

- What are major norms in adaptation cooperation and how compares their political codification in the UNFCCC regime to that in science and practice?
- What are major developments in the UNFCCC adaptation and loss and damage debate, what is the output of COP 21 and how will it impact on future science-policy and science-practice interactions?

Methodology: The study methodology consists of a systematic literature review as well as process outcome tracking of major UNFCCC decisions and results of the Adaptation Committee, the Nairobi Work Programme on impacts, vulnerability and adaptation to climate change and the Warsaw International Mechanism and its Executive Committee.

Findings: The UNFCCC is the major international cooperation architecture with obligations by states to initiate, plan, conduct and communicate adaptation actions, with norms on adaptation conduct ('principles of adaptation') and with obligations for developed countries to assist developing countries in meeting their adaptation needs. However, policy process and decisions in the UNFCCC so far only have limited bearing to science-practice debates. Policy process and decisions in the UNFCCC so far only have limited bearing to science-practice debates. The IPCC in its 5th Assessment Report for instance only takes minimal notice of the Cancun Adaptation Framework despite its high relevance for the UNFCCC process.

Significance for practical solutions: In terms of practical relevance the presentation will address this gap and provide a contribution for scientists and practitioners to access and evaluate the relevance of major adaptation and loss and damage policy outcomes for their respective disciplines.



ABSSUB-1390

A case for adaptation laboratories? The potential for radical realignment of adaptation paradigms

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Research question: This study aims to explore the potential for Adaptation Laboratories to facilitate a release from external constraints and provide a safe-space for diverse experimental ideas to be shielded and grow (Huq, 2015; Pereira, et al., 2015). Adaptation Laboratories draw on the concept of 'Living Labs'; the creation of conditions under which experimental procedures such as establishing baselines, monitoring and evaluation enable the effects of bottom-up adaptation innovations to be evaluated in a participatory manner that enables their effects to be validated before being upscaled (Evans, 2013). An adaptation laboratory has also a metaphorical connotation that encapsulates the interdisciplinary development of theories, models, instruments, strategies for the purpose of transformative learning on climate adaptation. Practitioners are interested in better understanding how local contexts become safe spaces that enable innovations for climate change adaptation (Inderberg et al., 2015). They are particularly interested in how these spaces can be leveraged in order to alleviate barriers to adaptation but lack clarity about the scope and character of these diverse initiatives.

Methodology: The study employs a literature review on current definitions and approaches of laboratories and how they are used in the climate adaptation field. The paper will draw upon examples of adaptation laboratories 'in the making' from different adaptation spheres, including natural disasters, mountain environments and urban contexts, as well as considerations regarding knowledge exchange. The study appraises the type of Adaptation Laboratories emerging and if they can provide new insights into climate adaptation options as well as how these insights might be able to feed into local/sub-national/national level adaptation planning processes.

Findings: Drawing on recent work on place-based adaptation and transformational adaptation the paper will discuss the wider relevance of adaptation laboratories to mainstream adaptation research and policy practice. The presentation sets out a theory of change for the long-term success and scalability of social-ecological innovations developed in these safe spaces.

Significance for practical solutions: It ends with suggestions to actors operating within the fields of development and adaptation for enabling laboratory environments and the role of coordination and networking across scales in this process.



ABSSUB-1053

Media discourse analysis on climate change in Chile: construction of public and political agendas

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Research question: This study seeks to understand digital media's representation of climate change in Chile, with emphasis on topics related to mitigation, adaptation and resilience. The media represents the primary source of climate change information for decision makers, the public, and pressure groups. Therefore, understanding the media's role and presentation of the subject within public discourse is imperative. The objective of this study is to reveal the framing and prevailing narratives on climate change in Chilean news media; these narratives play a fundamental role in determining public and political agendas.

Methodology: A critical discourse analysis was conducted of a body of 58 national news in order to identify existing power relations and the presence and absence of actors and narratives in the media. Methodology consisted of discourse analysis, applied to the four largest (by readership) digital media sources in Chile (two liberal and two conservative) using content analysis software. The research focuses on news published from the release of the Second National Communication on Climate Change (30/08/11) until the inauguration of the Center for Climate and Resilience Research (10/31/13).

Findings: The most relevant findings of the study include: (i) relatively little news on climate change in Chilean as compared to international media, 15%; (ii) identification of government actors as primary definers of the issue; (iii) an almost total absence of the public and NGOs in this discourse.

Critical discourse analysis reveals a high degree of consensus among actors (especially government and private sector), framing climate change as a possibility for ecological modernization and economic opportunity, and an absence of a critical ecology framework to counterbalance the aforementioned view. This imbalance might result in the design of public policies with heavy technocratic bias and ignoring the opportunity to build a more comprehensive vision of national development, in addition to the production and reproduction of structural conditions of vulnerability and exposure to natural disasters caused by climate change, ignoring the potential application of local and traditional knowledge and experience that are fundamental to the construction of adaptation and resilience.

Significance for practical solutions: The most relevant recommendations emerging from this study include: (a) the need for a segmented study of Chilean public opinion on climate change; (b) the need for a Chilean scientific community capable of connecting weather events to climate change; (c) the need for narrative structures for communicating climate change as the most appropriate way for people to be linked positively and to positively alter daily practices; (d) the relevance of framing human health as a driver for behaviour change towards styles of low-carbon life; and (e) the need for amendments to regulate the high degree of concentration of ownership of the media in order to integrate more voices and re-establish its role as a platform for public voices.



ABSSUB-1131

Monitoring and evaluating climate adaptation governance in Sweden

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Research question: In 2015 the Swedish Meteorological and Hydrological Institute (SMHI) completed a governmental mission to survey, analyse and follow-up on climate adaptation work in Sweden with a focus on impacts and needs at national, regional and local levels. The survey stressed that priority and funding should be given to research and development measures that fill an identified knowledge-gap, including long-term monitoring. Thus the survey outlined a "road map" of actions to guide further climate adaptation processes in Sweden. In the present paper, three of the authors of the survey ponder the research question of how the governance processes proposed by the "roadmap" might be monitored and evaluated in terms of potential impact. The paper proposes that a "territorial governance" perspective could be a useful in-road into such an assessment.

Methodology: The empirical basis of this paper builds on the SMHI survey, which in turn was performed by desk research, requests for written information from national and regional authorities, telephone interviews with significant actors and on a series of four workshops with public and private stakeholders during 2014 and 2015. This paper recaps the conclusions of the SMHI survey with a focus on the achievements and remaining challenges of climate adaptation work in Sweden. It introduces the "road map" proposed by the survey. It then suggests that using a "territorial governance" analytical framework might be an appropriate way of for the assessing the processes of current and future impact of climate adaptation. A territorial governance framework can be used to assess issues with a strong place-based or spatial planning character, such as climate change adaptation. Following the current operationalisation efforts in the literature, territorial governance is seen in terms of five dimensions: 1) coordinating actors and institutions, 2) inter-sectoral integration, 3) mobilizing stakeholder involvement, 4) adaptability of institutions to changing contexts, and 5) utilization of territorial knowledge in policy decisions.

Findings: The findings of the survey and the this paper conclude that climate adaptation in Sweden should be conducted in a long-term manner, that roles and responsibilities should be made more transparent and that better coordination among the many actors involved is necessary. There is a need to outline how the costs of adaptation should be distributed among stakeholders and how resources for prioritised measures can be guaranteed.

Significance for practical solutions: Sweden still needs to find a way to systematically monitor the impacts of the many on-going climate adaptation measures and processes. This paper shows how climate change adaptation processes in Sweden and the "road map" suggested by the SMHI survey could be monitored and evaluated by using the five dimensions of territorial governance. It may also help be useful as a practical process monitoring system in other countries.



ABSSUB-614

Local institutions and climate change adaptation governance in Hindu Kush Himalaya

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Research question: Constraints of terrain and resultant inaccessibility, fragility and socio-economic marginality pose severe challenges to mountain societies, particularly in developing and less developed world. However, mountain communities have developed distinctive mechanisms to adapt to these typical conditions through forming a range of institutions. Hence, institutions are particularly relevant in the context of mountains, as mountains and their inhabitants, especially in marginalized countries are increasingly vulnerable to climate change and its associated risks. Study aims to identify effective local institutions in Hindu Kush Himalaya, and to analyse their role in climate change adaptation governance in terms of their environmental, social and economic involvement, and in improving community access to new knowledge, technology, critical information and resources that are critical for climate change adaptation at local levels.

Methodology: The methodology included the comprehensive study of some the key local institutions, such as 'Van Panchayats' (Forest Councils) in Uttarakhand, India and 'Community Forestry' in Nepal based on the analysis of data and information collected through varied empirical sources including interactions, discussion, meetings and interview with a range of stakeholders, particularly local communities, government agencies, non-government and civil society organisations, and detailed field observations and mapping.

Findings: Results indicated local institutions have been playing significant role in climate change adaptation governance, particularly through disseminating critical knowledge, mobilizing resources and addressing marginality and fragility. Besides providing stability during times of climatic extremes, local institutions are improving adaptive capacity of communities through preservation and transfer of indigenous knowledge and its dissemination from one place to another and from one generation to next. Local institutions are critical control points in Himalaya that determine direction and magnitude of flows of resources, information, technology and knowledge to varying geographical units and different social groups. However, local and regional institutions have not yet comprehensively addressed the issues of poverty, livelihood, food security, gender inequality and social marginalization that affect entire process of climate change adaptation, mainly due to a lack of articulation among and access to institutions. This underlines need for capacity building and development of partnerships and horizontal and vertical linkages among different levels of institutions. This would facilitate improved community access to new knowledge, technology and critical information and encourage the movement of financial resources to local levels.

Significance for practical solutions: Study would play significant role in recognizing importance of local institutions in climate change adaptation governance and help in streamlining and strengthening them all across the mountain regions of the world.



ABSSUB-1013

Climate change adaptation policies in agriculture and rural development sector in Vietnam

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Research question: The study explores the extent of policy options to support adaptation to climate change especially in agriculture and rural development sector as major Vietnamese population is dependent on agricultural system that are highly affected by climate dynamism.

Methodology: The Policy Analysis Framework and the Joint Principles for Adaptation recently developed by the Southern Voices on Adaptation have been applied to review policy gaps and recommend policy options for climate change adaptation in Vietnam, particularly in agriculture and rural development sector.

Findings: Key findings show that although Vietnam in general, and agriculture and rural development sector particular has a quite larger number of policies for climate change response, current policy system still lacks proper addressing of private sector and local community involvement in climate change response. There are no concrete policies to encourage or create incentive for local people and private sectors to participate in climate change adaptation. Besides, there are no clear policies and mechanisms for financial investment (both internal and external funding) in climate change response; there is no concrete guidance to integrate climate change in current socio-economic development plans of the sector; the climate change action plan of the sector period 2011-2015 lacks clear identification of priority activities in the context of financial shortage.

Significance for practical solutions: a wide range of policy options are provided for better support to climate change adaptation in Vietnam, those include stipulations and guidance on participation of private sector and local communities together with mechanisms to create incentives and encourage them to participate in climate change mitigation and adaptation; A clear policy on financial investment for long term response to climate change; The integration of climate change in socio-economic development plans should be institutionalized and concrete guidance on this integration should be developed. For development of the climate change action plan for period 2016-2020, the broad consultation and a clear list of priority activities should be developed. A science and technology programme on climate change in agriculture and rural development sector is needed to create sound foundation for effective response activities. A system to monitor and evaluate effectiveness and impacts of different climate change measures is useful for long term climate change response activities. It is necessary to set up an early warning system of climate change impacts to agriculture production and food security. Research to develop model of climate smart agriculture which covers triple folds of climate change mitigation, adaptation and economic growth seems suitable to Vietnam to obtain optimum benefits in climate change response. Equally important is the strengthening capacity of relevant agencies of Vietnam in international negotiations and resources mobilization to implement climate change adaptation activities.



ABSSUB-1048

USAID's experience on climate-resilient development and National Adaptation Planning

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Research question: National adaptation planning has evolved from a focus on short-term, project-level interventions to mainstreaming adaptation into broader development goals. Initial adaptation efforts tended to focus on climate science and project-level assessments and measures. In contrast, National Adaptation Plans (NAPs) provide an opportunity to take a longer-term, more strategic approach to adaptation. A key challenge for adaptation has been to ensure that it is integrated into development planning. A "development-first," rather than "climate-first" or stressor-driven, approach enables climate change to be more effectively integrated into development planning and decision-making. A key issue is how to integrate climate change into development planning and avoid having adaptation planning be a process separate to development planning.

Methodology: The Climate-Resilient Development Framework, a development-first approach developed and tested by the U.S. Agency for International Development, begins with a comprehensive view of a country's social and economic development goals and key climate risks to those goals. The process then identifies adaptation actions that reduce the most significant climate risks to development. The process is used to support the National Adaptation Plan (NAP) process through stakeholder workshops involving government, private, NGO, civil society, and other stakeholders. The approach has been applied in stakeholder workshops in Barbados, Jamaica, West Africa, and Tanzania to help initiate the NAP process in those countries and regions.

Findings: The workshops succeeded in catalysing national climate change adaptation planning in a number of the countries. Lessons learned from these applications include the importance of local ownership and buy-in at an early stage, the value of rooting NAPs in an existing planning process to promote more effective mainstreaming, and the important role that NAPs can play in coordination of financial and technical support.

Significance for practical solutions: The use of NAP workshops can help not only to catalyse the NAP process, but also identify key climate risks to development and climate change adaptation policies.



ABSSUB-340

Building resilience of the great barrier reef thru partnerships, integrated plans & implementation

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Research question: How to build the resilience of the Great Barrier Reef to the threats of climate change, land based runoff, coastal land use change and direct use?

Methodology: A 4-year collaborative adaptation planning process for the Great Barrier Reef in Queensland, Australia between 3 levels of government, scientists, park managers, conservationists and traditional owners with farming, fishing, tourism and ports operators. Major elements of the process were a comprehensive strategic environmental assessment (SEA) to underpin development of an integrated sustainability plan; The Reef 2050 Long-Term Sustainability Plan. The Plan was developed and is being implemented by a multi-stakeholder partnership group.

Findings: The SEA found the Reef is under threat from 4 main inter-related pressures: climate change, land based run off, coastal land use change and direct use. The key to protecting Reef values for the future is to build overall resilience through proactively managing threats such as land based run off with water quality improvement programmes with farmers and direct threats with marine zoning. With an area of 348,000 square kms, the Great Barrier Reef is the size of Italy and, consequently initiatives to conserve values in the face of climate change and other pressures must be regionally and fit for purpose. The Plan's vision: 'To ensure the Great Barrier Reef continues to improve on its Outstanding Universal Value every decade between now and 2050 to be a natural wonder for each successive generation to come' is delivered through 7 Outcomes for 2050. SMART targets for 2020 and medium term objectives are specified for the 6 themes of Biodiversity, Ecosystem Health, Heritage, Water Quality, Community And Economic Benefits. Clear Governance actions and responsibilities ensure the Plan is implemented in an adaptive management framework. State and national governments are working with a stakeholder advisory committee in developing policies on net benefits and cumulative impacts for use by all public, industry and community decision makers.

Significance for practical solutions: The Reef 2050 Plan was a key component of the Australian's government response to the World Heritage Committee's concerns about the health and protection of the Great Barrier Reef World Heritage Area. The 21 World Heritage Committee member countries congratulated Australia on the Plan at its meeting in Bonn in June 2015. Implementation has commenced on the Plan including prioritization of actions by an independent expert panel of scientists chaired by Australia's Chief Scientist, development of cumulative impact, net benefit and offsetting policies and compiling an Integrated Monitoring and Reporting Programme. Industry is developing codes of practice for their activities in the Reef's catchments and along the coast. Local governments, schools, fishers and farmers are choosing to become Reef Guardians by adopting and sharing best practice approaches.



ABSSUB-835

Bolivian climate change adaptation experiences from the Altiplano norte region and Beni department

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Research question: Climate change impacts in Bolivia are already being felt throughout the country (dry spells, droughts, floods). Climate models predict a significant increase in temperature for Bolivia in the range of 2.2 - 7 °C by the end of this century. Thus, studying and discussing adaptation measures is becoming an ever more urgent task. This situation leads us to the formulation of our research questions: What is Bolivia doing to face the predicted impacts of this huge temperature rise, with all its associated effects? What are the politics, programmes and adaptation actions that are presently being implemented by the different levels of government, from national to regional, local and the community level? Our empirical study on climate change adaptation policies, programmes, projects and initiatives can be considered a first of its kind evaluation for Bolivia. It focuses on two different regions in its attempt to identify key actors, processes and experiences that will allow formulating orientation and criteria for public politics in order to help the country adapt successfully to present and future impacts of climate change. The first region is the Northern Altiplano, giving continuity to a previous study "Bolivia in a 4 degree warmer world. Socio-political scenarios "Bolivia in a 4 degree warmer world. Socio-political scenarios in the face of climate change for the years 2030 and 2060 in the Northern Altiplano" (Hoffmann & Requena, 2012). The other region is the lowland department of Beni, which experienced "historic" floods in early 2014; a region extremely vulnerable to climate change.

Methodology: Our empirical study is based on the results of visits to the regions, field observations and in situ interviews. In total, we visited more than 35 local administrative districts and interviewed around 100 persons. Our work was then complemented by extensive literature review, including a large number of technical reports compiled during field work.

Findings: The main conclusion we draw is that climate change adaptation in Bolivia is still in its early stages, and there is no generalized appreciation that adaptation will constitute a priority over the next couple of decades. A second conclusion is that there exists an enormous lack of information and knowledge on climate change and its impacts, as well as on possible adaptation measures. Third, Bolivia still does not have a national climate change policy.

Significance for practical solutions: Based on the conclusions of our study, we have formulated recommendations to orient activities for developing and implementing public policy on climate change adaptation. Even though these recommendations are directed towards the Friedrich Ebert Foundation, commissioner of the study, they may also serve other actors in the public and private sectors, as well as institutions of international development cooperation, in order to help Bolivia increase its resilience to climate change.





ABSSUB-833

The use of non-monetary metrics in adaptation decision-making

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Research question: The use of standardized or common metrics in economic assessments has been highlighted as a major area of development and research. There are several benefits in using such metrics. They can help evaluate, quantify and communicate the benefits of adaptation or climate-proofed policies and projects. The most commonly used type of economic assessment, Cost-Benefit Analysis (CBA), is based on the monetary valuation of all relevant costs and benefits to government and society of all options, so that the net benefits or costs can be calculated. However CBA is often difficult to apply for adaptation decision-making due to lack of data, the difficulty to monetise all important dimensions and its limitations in taking into account complex issues such as long time frame, high distributional nature of impacts, irreversible effects, or the existence of thresholds. Non-monetary metrics, developed through Cost-Effectiveness Analysis (CEA) and Multi-Criteria Analysis (MCA) can express multiple dimensions and take into account these issues. This paper therefore examines the current use of non-monetary metrics for supporting economic assessments in adaptation decision-making, with the aim of providing guidance on their further use.

Methodology: Literature review of cost-effectiveness assessments and Multi-criteria assessments in the adaptation literature.

Findings: This paper takes stock of the recent scholarship and outlines some key lessons learned and limitations on the use of non-monetary metrics in adaptation decision-making. The paper presents 1) an outline of key characteristics of non-monetary metrics and how they are developed in CEA and MCA, 2) a list of previously used non-monetary indicators, criteria and metrics for assessing adaptation options, and 3) an overview of their usefulness and limitations for informing adaptation decision-making. The adaptation literature on non-monetary metrics remains overall very limited, and it appears that most studies rely heavily on metrics developed in CEAs and MCAs for non-adaptation issues. Further studies using and developing non-monetary metrics in adaptation are needed.

Significance for practical solutions: The paper provides guidance for the further use of non-monetary metrics in adaptation decision-making.

ABSSUB-1168

Short term adaptation cost ? The case of Mauritius as a small island developing state

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Research question: Adaptation to climate change, how much will it cost? The case of Mauritius as a small island developing state. Human activities around the world are producing increasingly large quantities of greenhouse gases, particularly carbon dioxide (CO₂) resulting from the consumption of fossil fuels and deforestation. As confirmed by the IPCC in all its reports, Small Island Developing State like Mauritius has characteristics that make them especially vulnerable to the effects of climate change. These characteristics



include among others limited size, geographical dislocation, proneness to natural hazards and external shocks and limited adaptive capacity. The vulnerabilities resulting from these characteristics are exacerbated by the effects of climate change – which include rising seas, acidification of oceans, coral bleaching, coastal erosion, flooding, loss of biodiversity and more frequent and intense weather events such as cyclones. In terms of costs, small island states are expected to bear high adaptation costs. However, adaptation and protection costs have been systematically underestimated in the past. Recent analysis of UNFCCC estimated costs of adaptation have found that these are far too low, by a factor of two-three for many of the impact areas affecting small island states, including coastal and infrastructure protection. The impacts of climate change in Mauritius can be summarized as follows:

- Beach erosion due to Sea level Rise
- Coral bleaching
- Loss of wetlands, mangroves,
- Loss of agricultural lands and drop in yield
- Flooding of some coastal roads
- Higher frequency and intensity of cyclones/droughts
- Salt water penetration into soil and water table
- Decrease in land area and EEZ area
- Threat to coastal biodiversity
- Threat of diseases
- Threat to coastal infrastructure

With this scenario and in view of ensuring a sustainable future for both the present and future generations, Mauritius does not have any other alternative than to adapt to climate change impacts. Investment in infrastructure is necessary and so is spending on capacity, institution building and risk management. Although Mauritius has partly tapped the Adaption Fund under the Kyoto Protocol, yet adaptation will involve further costs to the population in terms of additional tax. This paper assesses the impacts of climate change and its associated costs over a short term period.

Methodology: Statistics and Econometric Modelling.

Findings: Cost of adaptation over the short term period.

Significance for practical solutions: Benefits to SIDS in estimating cost of adaptation.



ABSSUB-418

Enhancing climate change adaptation funding in Africa through microfinance

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Research question: Africa is one of the regions that is witnessing commendable levels of economic growth to the extent that six of the thirteen countries with the highest compounded annual growth rate from 2014 through 2017 are in Africa. However, such growth has not been inclusive hence poverty levels on the continent are increasing. Additionally, managing climate change is hampered by Africa's adaptation deficit as caused by a lack of institutional, financial or technological capacity to adapt effectively; and a lack of effective delivery mechanisms to channel climate finance resources at the sub-national level, particularly to target the poor who are also often the most vulnerable to the impacts of climate change. Climate financing for mitigation and adaptation should arguably be addressed with the same priority, but research has shown that the implementation of climate finance modalities are highly construed towards mitigation efforts whereby 91% of climate finance flows are for mitigation efforts, 7% for adaptation efforts and 2% for activities with both mitigation and adaptation objectives. Other researchers also point out 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.

Methodology: In-order to determine if microfinance can support entrepreneurship and investments focusing on climate change adaptation, this paper analyses and expounds upon the Microfinance-Climate Finance Framework that was shortlisted for the 2014/2015 UNDP MDG Carbon Climate Finance Innovation Award.

Findings: While factors such as political risk and a poor investment climate are usually considered as causes for underinvestment in Africa, arguably a lack of investments on the continent is not due to a lack of funding but a lack of 'packaged', 'bankable' projects; and a lack of business models and financing structures that can tap into the huge financial resources that are currently available in the private sector. For example, African migrants currently provide around \$40 billion a year in remittances, but have the potential to provide more than \$100 billion a year to help develop Africa. Climate resilient inclusive growth is therefore being hampered by a range of market, government and policy failures, and the absence of business models and financial innovations (e.g. co-investments, crowd-funding, etc.) that can facilitate investments.

Significance for practical solutions: The paper concludes that microfinance can leverage funding from various private and public sources hence provides a viable mechanism which can provide commercial returns to individuals and institutions, whilst facilitating the growth of inclusive businesses on the continent. Moreover, with increased financial inclusion on the continent, microfinance modalities can also support the Sustainable Development Goals of reducing inequality within and among countries.



ABSSUB-1241

Weather Index based Crop Insurance as an adaptive mechanism for climate change in coastal Bangladesh

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Research question: Crops of small and marginal farmers of Bangladesh are totally unprotected against disaster losses. Crop Insurance (CI) introduced during 1977-96 by General Insurance Corporation (SBC), a nationalized insurance company, was a complete fiasco. There was no grass-root level institutional setup to closely monitor the ground reality in crop production to avoid moral hazards of fraudulent claims. Government of Bangladesh is planning to reintroduce Crop Insurance (CI) as an adaptive measure against climate change. At present huge amount of interest free agricultural loans are disbursed under post disaster agricultural rehabilitation programmes. Instead of providing post disaster assistance, Weather Index Based Crop Insurance (WIBCI) can be introduced as an alternative. The question is whether WIBCI is a viable adaptive option for providing crop security to farmers in Bangladesh?

Methodology: Literature review, key informant interview to determine the probable institutional arrangement for administering Weather Index Based Crop Insurance.

Findings: Department of Agricultural Extension (DAE) can certify about the crop cultivation area, crop type, crop value, number of perils to be covered and insurance triggering climatic variables and their values. Insurance company can verify the DAE certification before offering insurance coverage. Government may pay the premium through budgetary allocation to Rural Development and Cooperatives Division (RD CD) instead of Ministry of Agriculture to avoid the conflict of interest as DAE provides crop certification. Bangladesh Meteorological Department (BMD) can certify about the values of weather index variables that will trigger the payment of indemnities. SBC, BKB may re-insure against private insurance companies. With the active participation of government institutions to build public confidence and private sector's involvement in providing WIBCI seems to be a viable option.

Significance for practical solutions: If WIBCI can be introduced, risk of moral hazard in the settlement of insurance claims will be eliminated. It will create a check and balance ambience where independent entities will cross check and verify the authenticity of insurance coverage, occurrence of climatic events, payment of indemnity etc. It will help building the asset base of the banking and insurance companies by reducing bad loans and fraudulent insurance claims. It will boost up the insurance market by spending the same amount of money spent for government subsidies and post disaster rehabilitations for paying the insurance premium. It will reduce the dependency on post disaster relief and rehabilitation operations. It will boost up agriculture sector too as crop farmer will be covered against disaster risks. At the same time climate victims will be more resilient to climate induced disasters.



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