A decision-making framework for flood risk management based on a Bayesian Influence Diagram

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Abstracts

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19:00	**Conference Dinner at Sagafjord in Roskilde Fjord**			

Wednesday August 27 2014				
8:00	Registration			
9:00	**Plenary – Theme 4: Low probability/high impacts** Jens Hesselbjerg Christensen (CRES, DMI, Denmark) Grete Hovelsrud (CICERO, Norway) Francis Zwiers (Pacific Climate Impacts Consortium, Canada)			
10:00	Refreshments			
10:30	**Theme 1: IPCC AR5; so what now?**	**Theme 2: Mainstreaming**	**Theme 3: Limits and opportunities**	**Special: Managing climate change in Nordic cities – challenges of implementation**
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	Environmental multi hazards from increased precipitation in coastal urban areas – Knowledge for adapting without causing second consequences - Gunnel Göransson	The role of insurers in mainstreaming climate-related actions - Lára Jóhannsdóttir	Optimal Decision Making, Adaptation to Climate Change in the Agricultural Sector- Lea Ravnkilde Møller	The role of socio-cognitive and cultural factors in the implementation of the Copenhagen adaptation and mitigation strategies - Mia Landauer, Patrick Driscoll and Sirkku Juhola
	Vulnerability of cross-country skiing to climate change in Finland – Interactive mapping tool - Neuvonen, Marjo		Smart pre-breeding of barley for a future climate with concurrent hazards - Cathrine H. Ingvordsen	Risk, role and responsibility of home owners in climate change adaptation- Nina Baron
12:00	Lunch			
13:00	**Panel discussion (Moderator: Hans Sanderson)** **(Panel: Hans von Storch, Kirsten Halsnæs, Martin Olesen, Emilie Ölander, Lará Jóhannesdóttir & Markku Rummukainen)** **Closing Plenary (Jens Hesselbjerg Christensen)**			
15:00	- -			

Opening plenary

The Working Group II Contribution to the IPCC 5th Assessment Report

Chris Field; Co-chair IPCC WG II
Vicente Barros; Co-chair IPCC WG II

The Working Group II contribution to the IPCC 5th assessment report, released March 31, 2014, is an update on scientific understanding of climate change impacts, adaptation, and vulnerability. Building on a massive increase in available literature, the WGII contribution addressed a broader range of topics than earlier assessments. In particular, the assessment expanded in the areas of adaptation, human impacts and vulnerability, and oceans.

The WGII contribution conceptualizes the challenge of responding to climate change as a challenge in managing risks. This formulation improves the integration of climate change responses with historical activities while also aligning effectively with the characteristics of projected futures.

Six major themes summarize the WGII contribution to the Fifth Assessment Report. These are:

1. Climate-change impacts are evident around the world. These impacts are widespread and consequential.
2. People, societies, and ecosystems around the world are vulnerable and exposed to climate change, in different ways.
3. Adaptation is already occurring.
4. Climate change is a challenge in managing risks.
5. Risks are much greater with continued high emissions than with ambitious mitigation. Large magnitudes of warming increase the likelihood of severe and pervasive impacts that may be surprising or irreversible.
6. Effective climate-change adaptation can help build a richer, more resilient world in the near-term and beyond.

The WGII contribution to the IPCC 5th assessment report provides a conceptual map of both the problem space and the solution space for climate change impacts, adaptation, and vulnerability.

Helsinki 2012: Adaptation research met adaptation decision-making ? what emerged?

Carter, Timothy R.; Finnish Environment Institute (SYKE)
Perrels, Adriaan; Finnish Meteorological Institute
Hildén, Mikael; Finnish Environment Institute (SYKE)

In August 2012 over 250 participants gathered in Helsinki for the Second Nordic International Conference on Climate Change Adaptation: Adaptation Research meets Adaptation Decision-Making" (NORDCLAD-Net/NONAM, 2012). This paper examines some of the issues raised at the conference and offers selected observations, from the three co-organisers, of insights that emerged." The conference was a joint initiative between two NordForsk-funded Nordic research networks: NORDCLAD-Net and NONAM, with co-funding from Mistra-SWECIA, the Academy of Finland and the City of Helsinki. It attracted attendees from 30 countries, including researchers across a range of disciplines, public and private decision-makers, regional and local planners, professionals with a background in risk management as well as representatives of NGOs and international organisations. A number of Nordic PhD student also participated, having attended a pre-Conference PhD Workshop at the same venue. The conference was organised around five themes, adapted from Eakin and Patt (2011): Risk assessment and impact response, Vulnerability and adaptive capacity, Building resilience, Policy development and implementation and Cross-cutting issues in adaptation. Using these themes as a loose framework, 100 oral and 49 poster presentations were included in the final programme along with keynote presentations and Panel discussions. The policy context included the ongoing preparation of an EU adaptation strategy (subsequently published in April 2013), the earlier launch of a European climate change adaptation platform, Climate-ADAPT, at the European Environment Agency, and the development of similar initiatives in many member states. Abundant evidence was presented to demonstrate how progress is being made under each of the conference themes. Some useful insights distilled from the proceedings included: Open data policies, an emphasis on equity and transparency and outward looking perspectives are important ingredients for addressing adaptation Improved understanding and learning is a necessary condition for collaborative and trans-disciplinary effort to increase adaptive capacity Uncertainty over impacts should not automatically result in inaction. By developing collaborative approaches it is possible to reframe adaptation tasks in terms of what we know (confidence) instead being paralysed by lack of knowledge ?Attempts to communicate information on adaptation through online portals and other services are proliferating, but their effectiveness remains to be evaluated. The interest and involvement of the private sector in climate change adaptation is growing rapidly, but there are still many areas to be explored. Three related types of response, each of which is necessary for effective adaptation, could be identified: practical (technical solutions), political (systems and structures) and personal (assumptions and beliefs). The latter two are less well understood, yet both may present significant barriers to progress ?Adapting to, or avoiding, undesirable outcomes of climate change requires societal transformation, but the processes through which such transformations might occur are only beginning to catch the attention of researchers and decision-makers. Feedback from participants suggested widespread approval for staging such a forum in a Nordic setting, and encouragement to stage similar events in the future. Some also expressed a preference for a format that would allow for additional time to be devoted to cross-community (research-policy-practitioner) discussions, poster sessions and presentations by young researchers. This suggests that the field of adaptation to climate change is evolving towards practical applications, creating a need for more collaborative action along with activities that promote collective learning, involving public and private actors and researchers and practitioners across a range of sectors and disciplines.

Eakin, H.C. and Patt, A., 2011. Are adaptation studies effective, and what can enhance their practical impact? WIREs Climate Change 2: 141-153. NORDCLAD-Net/NONAM, 2012. Adaptation Research meets Adaptation

Decision-Making: Programme and Abstracts of the Second Nordic International Conference on Climate Change Adaptation, 29-31 August 2012, Helsinki, Finland, 72 pp. http://www.nordicadaptation2012.net/

Plenary - IPCC AR5; so what now?

Keynote

Neil Strachan; IPCC WG III

Climate Change 2013: The Physical Science Basis - Highlights from the latest IPCC report

Gian-Kasper Plattner; IPCC WG I

CO2 concentrations in the atmosphere are now unprecedented in at least the last 800,000 years, and they rise more than 100 times faster than during the past 20,000 years. This is caused by anthropogenic emissions of greenhouse gases by burning fossil fuels and land use change with consequent changes in the entire Earth System. The newest comprehensive assessment Climate Change 2013: The Physical Science Basis by the Intergovernmental Panel on Climate Change documents a rapidly and profoundly changing Earth System and provides the latest understanding of changes ahead of us. Over 2 Million Gigabytes of numerical data from climate model simulations permit an assessment of future changes whose magnitude and impact depend on our choices today. Cumulative carbon emissions determine the peak warming in the 21st century and serve as a tool to assess which climate targets are still achievable.

Policy-making for an uncertain future

Jane Ellis; OECD

Monday session - IPCC AR5; so what now?

Developing the skill of multi-annual climate prediction

Ralf Döscher; Swedish Meteorological and Hydrological Institute (SMHI)
Francisco J. Doblas-Reyes; Catalan Institute of Climate Sciences (IC3)
Mihaela Caian; Swedish Meteorological and Hydrological Institute (SMHI)
Klaus Wyser; Swedish Meteorological and Hydrological Institute (SMHI)
Torben Koenigk; Swedish Meteorological and Hydrological Institute (SMHI)

Climate predictions, as opposed to climate scenario projections, initialize global climate models with observations to approach the real state of the climate system. Predictability studies indicate that forecasts up to a decade might be skillful. The presentation summarizes the current state of multi-annual prediction with a focus on Europe, and discusses the future development potential. Success and skill of real world forecast depends on the GCMs, their resolution, the forcing, the ensemble set-up and especially on the initialization method. Those challenges are systematically addressed by the ongoing EU project SPECS. Preliminary results on effect of different resolution and initialization will be shown. Skillful climate prediction requires the existence of forcing signals. In nature those exist in the form of solar variability, volcanoes, teleconnection patterns, anthropogenic forcing and trends. A climate prediction model thus needs to be capable to realistically simulate the models response to external forcing and reproduce internal processes connected to predictability. Initialization procedures need to capture the slowly varying climate signal of the real world that represents the major uncertainty in decadal scale climate projections. The objective of initialization is to start the climate model from conditions as close as possible to observations in a way which fits the specific models dynamic character. So far, different methods of direct insertion or nudging (anomalies and full-field) have been applied and resulted in improved skill compared to persistence. Examples from the EC-Earth model will be shown. Further improvement is expected from more accurately initializing the observed phase of natural oscillations into the models preferred patterns of oscillation. The main observed modes of variability are projected on the models orthogonal basis ensuring stable initial conditions while preserving the models range of variability. Further development of initialization techniques will need to take into account more sophisticated methods such as improved nudging, Kalman filtering or adjoint methods. In addition, coupled initialization of ocean, sea ice and land surface in consistent ways represents a challenge. High predictability is generally achieved over the North Atlantic ocean and in the Arctic. Recent multi-year predictions (e.g. based on the EC-Earth climate model) give a significantly higher predictability of air temperature over a number of European regions. A possible reason for the improvement might be the increasing resolution. Most of the highest potential predictability areas over land are adjacent to areas with high predictability over sea. Northwestern Europe is a densely populated area where multi- annual predictions have highest potential for further improvement. An important message comes from the EC-Earth models ability to reproduce the decadal variability of regional climatic extremes. A recent study at SMHI points out that initialization is systematically improving the prediction of extremes and severe conditions over Europe. The skill of Atlantic hurricane activity is found to benefit from initialized simulations, mostly due to capturing changes in Atlantic sea surface temperature. Current multi-annual climate prediction experiments show growing predictability over Europe in addition of the North Atlantic and Arctic. Skill over the European terrestrial areas depends very much on the state of the North Atlantic and its variability modes such as the AMO. A precondition for skillful prediction is a realistic representation of natural oscillations. Reasons for recent progress are increasing resolution and development of initialization techniques guided by improvement of skill. Forthcoming progress in multi-annual predictability, even for regional areas, is expected to arise from more sophisticated initialization methods and from exploring suitable ways of coupled initialization.

Improved regional scale projections using integrated climate and hydrology modelling

Larsen, Morten Andreas Dahl; Technical University of Denmark
Drews, Martin; Technical University of Denmark

The study presents results from newly developed modelling tool dynamically coupling a regional climate model with a hydrological model to include a wider and more detailed range of hydrological processes and to include land- surface/atmosphere interaction and feedback effects. Observations and climate projections provide evidence that water resources are vulnerable and subject to a high potential impact by climate change with wide implications for human societies and ecosystems [1]. An improved understanding of feedback and interaction mechanisms between the atmosphere and the land surface is therefore crucial. Something which is especially true in light of expected global warming and increased frequency of extreme events. The skill in developing projections of both present and future climate depends essentially on the ability to numerically simulate the processes of atmospheric circulation, hydrology, energy and ecology. Contrary to previous modelling efforts using each model in sequential steps, the present study presents a modelling tool dynamically coupling a regional climate model (HIRHAM) with a hydrological model (MIKE SHE) to fully include the land-surface/atmosphere interaction and feedback effects. To the knowledge of the authors this is the first coupled study to include long term simulations (years) between a regional climate model and a detailed 3D hydrology model. The results presented here include a large number of analyses in hindcast mode as a part of the overall modelling system applicability and parameterization. However; in the context of climate change the coupled modelling tool holds great potential in terms of both improved regional future climate projections as well as the effect climate change on water resources as these are tightly linked. In the coupled modelling tool the land- surface/atmosphere interaction is utilizing the MIKE SHE/SWET land surface model (LSM) which is superior to the LSM in HIRHAM. A wider range of processes are included at the land surface, subsurface flow is 3D distributed and the temporal and spatial resolution is higher. Also, the feedback mechanisms of e.g. soil moisture and precipitation between the two models are included. The present MIKE SHE setup was performed for the Skjern River catchment (2500 km2) whereas the HIRHAM domain had a 4000 km x 2800 km extent. A primary analysis in the modelling setup assessed the optimal data transfer frequency between the models in terms of performance and simulation time, and from the investigated 12-120 min transfer intervals, 30 min was found suitable. The HIRHAM internal model variability, as specifically noticeable in precipitation output, was also assessed using multiple perturbed simulations and was seen to make up a evident part of the model output variation although differences between coupled and uncoupled results were significantly higher. Further, multiple simulations were performed in periods of extreme and non-normal weather (in terms of precipitation and temperature) to assess the coupled performance against the well- documented uncoupled HIRHAM model biases. Based on these studies of the coupled modelling tool the overall usefulness is highly evident and the system provides a potentially valuable input to regional climate projection studies. Using multiple coupled simulations focusing on both the optimal interval of data transfer between the two models as well as periods of more extreme weather, the modelling tool is seen as highly feasible and is potentially highly useful in future regional climate studies.

[1] Bates, B.C., Kundzewicz, Z.W., Wu, S. and Palutikof, J.P. (Eds.) (2008) Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.

Projecting precipitation intensities in Scandinavia under a changing climate

Fox Maule, Cathrine; Danish Climate Centre, Danish Meteorological Institute
Mayer, Stephanie; Bjerknes Centre for Climate Research
Christensen, Ole B.; Danish Climate Centre, Danish Meteorological Institute

Here we present the projected changes in precipitation over Scandinavia in the 21st century for two future scenarios, RCP4.5 and RCP8.5, based on four dedicated model simulations of ~8 km horizontal resolution centered over Denmark. The basis for adapting to climate change is knowing what to adapt to. As many adaptation measures to infrastructure are costly and may take several years to plan and implement, knowledge of the future climate, and particularly its extremes in different places, is essential. In the RiskChange project the main objective is to establish a consistent framework for risk-based design of critical infra- structure (cities and municipalities, coastal protection, off-shore industries) which accounts for projected climate changes in extreme weather events over central Scandinavia. For this project dedicated downscaling experiments of two different global climate models (GCM) using two different regional climate models (RCM) have been carried out in a very high-resolution grid centered over Denmark. Studies (e.g. Christensen and Christensen, 2003; Barstad et al., 2009; Soares et al., 2012) have shown that in areas with complex topography or coastlines increasing horizontal resolution improve the model performance. Thus for this study, focused on Denmark and Norway, which are two countries characterized by complex coastlines and for Norway highly variable topography, the wish was to use a high horizontal resolution and to store output at a high temporal frequency. The experiments carried out uses a horizontal grid spacing of about 8 km and the output of central variables as temperature, precipitation, pressure and wind-components is stored hourly. As these simulations are computationally expensive and require large data storage capacity running 30- year time-slices was favored over transient simulations. For validation of the RCMs, they have been run with ERA-interim re-analysis data on the boundary allowing us to determine model biases; this is the topic of a recently submitted manuscript by the authors. For the purpose of projecting climate change the two RCMs have both been driven by two GCMs for a historical time-slice, 1981-2010, and two future time-slices, 2021-2050 and 2071-2100 under two different radiative forcings, RCP4.5 and RCP8.5. Here we will present the projected changes in the frequency of wet days and wet-day intensity for Denmark, Norway and Sweden for the middle and end of the century, as well as projected changes in hourly precipitation intensity, compared to the baseline period, 1981-2020. From the simulations we find that the seasonal mean precipitation does not change significantly, but we see a decrease in the wet-day frequency and an increase in the wet-day intensity in summer (JJA) in both Denmark and Sweden.

Barstad et al. (2009). Precipitation, temperature and wind in Norway: dynamical downscaling of ERA40. Clim. Dyn., 33(6):769-776. Christensen and Christensen (2003). Climate modelling: severe summertime Ooding in Europe. Nature, 421 (6925):805-806. Soares et al. (2012). WRF high resolution dynamical downscaling of ERA-Interim for Portugal. Clim. Dyn., 39(9-10):2497-2522.

Nordic collaboration within Climate Services

Førland, Eirik J.; Norwegian Meteorological Institute
Lindström, Lena; Swedish Meteorological and Hydrological Institute
Hanssen-Bauer, Inger; Norwegian Meteorological Institute

The Nordic Framework of Climate Services, NFCS is collaboration between the climate services at the Nordic meteorological institutes. Main objective of NFCS is to boost the availability of climate information in the Nordic countries, by developing and sharing best practices in data handling, climate service products and communication with users. The Nordic Framework of Climate Services, NFCS was established in 2011 in collaboration between the climate services at the national meteorological institutes in Denmark, Finland, Iceland, Norway and Sweden. Main objectives of NFCS are to boost the availability of climate information in the Nordic countries, by developing and sharing best practices in data handling, climate service products and communication with users. NFCS activities are complementary to those carried out by the Member NMHS and focusing on elements where integration could be beneficial. NFCS will jointly provide data and expertise, collaborate on developing tailored climate products, promote methodological development, and develop ways of communicating scientific content of climate information in an understandable format. The NFCS user dialogues and dissemination of climate information is performed through the national Nordic Climate Service Centers, web-sites, reports, meetings with counties and municipalities, etc. Main NFCS activities: - High-quality homogenized Nordic climate dataset (1890-present). Common methods and tools are used for homogeneity testing and adjustment for inhomogeneities. - Climate Service products based on spatial interpolation. The open data policy of the Finnish, Norwegian and Swedish meteorological institutes now opens the possibility to produce joint Nordic gridded datasets of daily temperature and precipitation. The dataset (1961-present) will be regularly updated and made available at the NFCS-web site. Arctic climate: A survey of Nordic NMHs links to relevant web-pages on Arctic climate is made available at the NFCS website -Climate Normals 1981-2010: Fennoscandian maps of temperature anomalies between the period 1981-2010 and the standard normal period 1961-90 are made available at the NFCS web-site. - Heavy rainfall: Information on present and future design values for short-term heavy rainfall is made available at the NFCS and KSS web-sites. The current design values are higher for Denmark than for Sweden and Norway. Projections indicate increasing intensities and frequencies of heavy rainfalls in Fennoscandia. - Future climate development. NFSC will deal with harmonization of information concerning national and Nordic climate projections and elaboration of tools to access these. A special focus will be on developing user-tailored scenarios and derived products. NFCS will also advice on how to present information on uncertainties and provide robust results to users. - Sharing / demonstrating good practices from communication with users. Within NFCS information is exchanged on e.g. sea level rise estimates /management, dissemination of tailored climate data for planning and adaptation, Nordic contributions supporting GFCS, experiences from international Climate services meetings, etc. " -

NFCS: Nordic Framework for Climate Services: http://blog.fmi.fi/nordmet/ KSS: Norwegian Climate Service Center: www.klimaservicesenter.no

Monday session - Mainstreaming

Communicating and visualising climate projections – user preferences and abilities amongst adaptation practitioners in local authorities in Germany

Susanne Lorenz, Suraje Dessai, Jouni Paavola and Piers Forster
Centre for Climate Change Economics and Politics, School of Earth and Environment,
University of Leeds, Leeds, UK

This paper finds that not only is the use of multi-decadal climate projections in local government planning impacted by the degree of progress on adaptation at local level, but that the level of understanding of the information content of the projections and the preferences for their visualisation can vary significantly amongst local government practitioners.

The research on communicating climate change has long suggested that decision-relevant provision of climate science and related uncertainties needs to be audience specific. In the field of climate change communication, past research has focused largely on the verbal and written communication of uncertainty (e.g. Budescu et al. 2009), but increasingly attention is given to the visual communication of uncertainty and there has been a call for more experimental evidence in this area (Spiegelhalter 2011). Empirical evidence of the extent to which adaptation practitioners use and interpret visually communicated multi-decadal climate projections and their uncertainties in adaptation planning is however sparse.

Focusing on the communication and use of climate projections, this paper presents results from 32 semi-structured interviews, predominantly in North Rhine-Westphalia, and an online survey conducted with 63 adaptation practitioners at local government level from across Germany. The aim of the survey was to see not only how the respondents understand different visual styles of presenting climate change projections that portray the same information content but also their preferences for using these in the planning and communication process for adaptation in their organisations.

The interviews highlight that despite adaptation occurring at local level, many German officials consider it to be only in the starting blocks, with many of them emphasizing the perceived adaptation-supporting impact of a more extensive regulatory framework. Furthermore, climate projections are often regarded to be too detailed and technical to be relevant for the current stage of adaptation planning. Consequently we find that the use of climate projections in German Local Authorities is not of a homogenous nature, but currently only seen in individual cases with more emphasis generally given to past and current climate data.

In addition, the results from the survey show that even if adaptation practitioners were to use climate projections, their interpretation and inclusion in the planning process would vary substantially. The survey highlights that there are significant variations in how different graphical visualisations of climate projections that portray the same information content are interpreted, assigned user confidence in their own assessment, used and incorporated into the decision-making process. Furthermore, we find different graph formats impact on respondents' confidence in their assessment of the information portrayed.

Given the distinct variation in user understanding and preferences we suggest that providing multiple and complementary visual formats for the users is likely to address their preferences and differing needs for complexity more adequately than a 'one-size fits all' approach. However, at the same time the use of climate projections in local government appears to be constrained by the level of progress and statutory regulation on adaptation planning.

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A quantitative assessment of the effectiveness of climate change communication in promoting engagement with adaptation

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The success of climate services is determined by its effectiveness to communicate its knowledge to certain target groups and make it actionable. This study assess the effectiveness of climate change communication in promoting engagement and learning about climate science and adaptation among forestry stakeholders. Climate change is expected to profoundly affect forests in Scandinavia in the coming decades. Expected changes will affect the frequency and intensity of extreme temperature and precipitation events. Warming temperatures may also promise some economic benefits. Governments and scientists are increasingly seeking to promote learning and engagement with measures that can help forest owners to cope with climate-related risks and exploit new economic potentials. Climate change communication (CCC), that is efforts to disseminate scientific knowledge about adaptation measures and promote their implementation take a central place in the emerging field of climate services Despite its growing popularity, quantitative assessments of CCC are largely absent in the scientific literature at this point. The objective of this study is to close this gap, and to assess the effectiveness of CCC in promoting engagement with climate science and adaptation among forestry stakeholders. The study asks if CCC can lead to cognitive, affective and relational learning and changes in attitudes and behavior regarding adaptation to climate change risks. In detail, this study will assess if perceptions and attitudes about climate risks and adaptation options significantly differ between forest owners that have and forest owners that have not participated in CCC. Findings are based on a survey comprising responses from approximately 6000 forestry owners in Sweden of which half took part in a CCC project carried out by the Swedish Forestry Agency. Multivariate regression and related statistical 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. The study also examines the influence of preference for different forestry objectives, personal experience with extreme events, trust in climate science, gender, age, social capital, education and dependency on income from forestry activities as well as other factors on the perception of climate change risks, the efficacy of adaptive measures and their own ability to adapt to climate change. Results from the study will offer valuable insights into how existing CCC can become more successful in engaging certain target groups with climate change. Key insights suggest that CCC can be improved if it more purposely addresses the varying objectives, needs, experiences and decision making processes of different user groups of climate services.

This presentation will present preliminary findings. The survey will be completed until June. Data analyses will commence in June.

Climate adaptation and institutional change in Norwegian stormwater management

Kyrre Groven; Vestlandsforsking

An ongoing shift in the water sector of Norwegian municipalities encourages a more proactive and cross-sectoral approach to stormwater treatment, including strategies for delayed runoff and 'blue-green' infrastructure, however restrained by numerous obstacles. This process is analyzed as institutional change and discussed from a new institutional theory perspective. In a case study of the water sector in five Norwegian municipalities, Hovik et al. (Accepted) find a rather proactive view on climate adaptation, and a call for decentralized 'green' solutions in stormwater management. Water engineers complain about resistance among land use planners when the water sector promote cross-sector cooperation. These findings were unexpected as previous research draws a picture of a compartmentalized water sector with weak horizontal couplings, oriented towards its own professional networks and national authorities, and with a reactive attitude to adaptation, based on centralized solutions. The authors suggest that the change can be ascribed to knowledge transfer on climate adaptation downwards within the water sector. The proactive and cross-sectoral approach in the water sector observed by Hovik and colleagues corresponds with my own findings in major Norwegian cities, where attitudes to stormwater management have changed under the last decade (Groven 2013). Most salient is the new strategy to delay runoff rather than quickly dispose of stormwater by conveying it to a recipient through the sewer system. Several conditions have made the sector more susceptible to the concept known as sustainable drainage systems (SUDS): Densification driven increase of impervious surfaces, restricted sewer capacity, more frequent flash floods, and climate projections indicating that losses will continue to rise. What seems to be a new paradigm manifests itself as mandatory stormwater planning as part of all regulations and building plans (the cities of Bergen, Trondheim and Stavanger), demand for retention of precipitation and melting water within development sites, and reopening of urban waterways. However, there are significant obstacles for the new principles to be implemented: The change is mainly taking place in bigger cities, even though smaller municipalities face similar challenges. Further, most chosen SUDS solutions are not 'blue-green' but 'grey' (buried retention structures), missing the positive effects vegetation treatment may have on water quality, biodiversity and amenity. Observed obstacles include land use conflicts, weak anchoring of new ideas in parts of the municipal organisation, ideological resistance against expropriation of private property, financing constraints, and immature SUDS technology unsuitable for Nordic winter conditions and with unsatisfactory documented performance, causing concern for operational difficulties. The ongoing shift represents institutional change and will be discussed from a new institutional theory perspective. The following questions will be addressed: Can the reported sectoral divide be confirmed, and in that case, how could it be understood? Which are the roles of institutional entrepreneurs, which institutional barriers operate, and are these factors conducive to varying adaptation efforts in the stormwater management of Norwegian cities? Do we witness a paradigmatic shift in the water sector ? either through competing institutional logics (Thornton et al. 2012) or as one paradigm replacing another, opening for a translational interpretation (Czarniawska et al. 1996) ? or do the changes prove to be pragmatic rather than paradigmatic?

Czarniawska and Sevón (1996). Translating Organisational Change. de Gruyter. Groven (2013). Eit politisk skred. Korleis naturskadeførebygging og klimatilpassing kom på dagsorden i Bergen kommune." In: Mot en farligere fremtid? Om klimaendringer, sårbarhet og tilpasning i Norge. Bye et al.(eds.), Akademika. Hovik, Naustdalslid, et al. (Accepted). "Adaptation to climate change: professional networks and reinforcing institutional environments" Environment and Planning C. Thornton, Ocasio and Lounsbury (2012). The Institutional Logics Perspective. Oxford. "

ADAPTING TO CHANGING FLOODS: THE ROLE OF THE NORWEGIAN CENTRE FOR CLIMATE SERVICES IN TRANSITIONING RESEARCH TO OPERATION

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Climate change will alter the magnitude and frequency of floods. Land use planning is seen as a key climate change adaptation tool to prevent increasing damages. This paper presents how climate cervices can help to facilitate the use of information about future floods in land use planning in Norwegian municipalities. Hydrological projections for floods in Norway under a future climate (Lawrence and Hisdal, 2011), show that increasing temperatures and changes in precipitation will alter the flood regimes. Ensemble modelling based on locally-adjusted precipitation and temperature data from 13 regional climate scenarios in conjunction with multiple hydrological models for 115 individual catchments is used to assess likely changes in river floods. Spring snowmelt floods are expected to decrease in the major rivers where snowmelt is the dominant flood generation process. In rivers currently dominated by rainfall floods, floods are expected to increase in the future. In particular, smaller tributaries will yield more frequent rapid, flash flooding caused by localised cells of intense precipitation. Climate and hydrological projections are inherently associated with uncertainty. However, despite differences in the magnitude of projected changes, the direction of changes in climate and hydrology are clear and, hence, there are no grounds for delaying progress towards adaptation. An important part of an adaptation strategy, in fact, is an assessment of how this uncertainty should be taken into account. Due to the uncertainties in the projections for individual catchments and to the need to generalise the results to areas outside the calibrated catchments, a pragmatic solution was to propose three categories for use in climate change adaptation: no change, 20 % increase and 40 % increase. The Norwegian Meteorological Institute (MET Norway), the Norwegian Water Resources and Energy Directorate (NVE) and Uni Research Ltd. have formed the Norwegian Centre for Climate Services (NCCS) focusing on providing the municipalities and decision makers in Norway with tailor made data for climate change adaptation. NCCS participates in a pilot study in Northern Norway to identify the needs for climate and hydrological information in selected municipalities, and how to integrate available information in their planning procedures. The focus area includes the city of Tromsø, and the three rural municipalities. The need to bridge the gap between research output and the operational needs of the municipalities in various planning processes at different levels of detail was confirmed. Even if the selected municipalities have identified substantial challenges in preparing for future as well as present floods, a major part of the required information is not available or not applicable in its present form. For example, flood observations and flood inundation maps are useful tools in land use planning, but often such data do not exist. The pilot project is important in helping to understand how the NCCS can help facilitate climate change adaptation in Norwegian municipalities. The centre, being an intermediate player between data providers and users must consider a number of issues including, different user needs, communication with various user groups, capacity building, requirements in laws and guidelines, different planning processes, amongst others. Because of the lack of data about present day conditions, e.g. floods, and the uncertainty in specifying the magnitude of anticipated changes, very simple, robust and pragmatic approaches, which can be used in practise, may be needed.

Lawrence, D., Hisdal, H. (2011). Hydrological projections for floods in Norway under a future climate. NVE Report no. 2011-5, 47 pp.

Innovations in weather and climate services ? Analysis of key technological and social factors shaping the future adaptation capability

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Pilli-Sihvola, Karoliina; Finnish Meteorological Institute
Nurmi, Väinö; Finnish Meteorological Institute
Perrels, Adriaan; Finnish Meteorological Institute

Weather and climate services provide an opportunity to reduce weather-related costs and damages through improved preparedness and response. Thus, innovations in these services will significantly affect the climate change adaptation capabilities of societies. This study analyzes the trends and factors shaping the future of production and use of these services. Weather and climate services (WCS) are an example of an efficient, low-regret adaptation activity. Regardless of the exact changes in climate and the impacts it will bring, improved preparedness and warning systems can reduce the damage and help seize positive opportunities. In order to understand the role of these services in adaptation, innovations have to be considered. The field of WCS is currently under transition, as new technology enables unprecedented improvements in quality and coverage of observations and modeling, as well as new communication options. This development, supported by open data policies, enables diversified service supply and new business opportunities. Furthermore, improved support for current operations is emerging. In these conditions, a new role for national hydro-meteorological services is shaping. Currently the services rely largely on publicly funded scientific work and instruments, thereby making policy decision an essential factor in their future development. This study analyses the technological, social and market trends for the entire supply chain of weather and climate services from the initial steps of collection of observations and production of information up to the end users by using a Weather Service Chain Analysis framework, which aims to account for the inadequacies in the production, dissemination and use of weather and climate information. The research questions are the following: - What are the key trends inside and outside WCSs affecting the near and medium-term development of these services? - To what extent is the development dependent on public funding and policy design? The study reviews the developments in key enabling technologies for WCSs, such as satellites and IT sector, as well as the changing environment in end use brought by mobile technologies. In professional end use, the focus is on transport, energy and tourism sectors and how enhanced WCSs could improve operations and adaptation in these sectors. The study is based on mixed methods research. The data gathering included semi-structured interviews of experts in the field of WCS services, information and observation technologies and end-user organizations, statistical user analysis for online weather services, market research and literature review. The results provided are useful to both experts and policy makers. They support the service development within the WCSs and enable more informed adaptation policy design. The study was conducted as part of an EU FP7 funded project ToPDAd (Tool-supported Policy Development for Regional Adaptation). Preliminary results have been discussed in a project delivery report [D2.2]. Innovations in WCSs entail a large diversity of technologies, as well as social and organizational changes. On one hand the development seems favorable, mostly due to the reduction of unit-cost in digital processing. Crowdsourced observations and ubiquitous micro or nano-scale instruments are examples of technologies that can enable continued improvements in the spatial and temporal accuracy of a forecast. On the other hand, the services are likely to require major publicly funded investments in order to materialize the benefits, since significant share of the necessary infrastructure both in the production and application of meteorological information has public good characteristics.

Perrels, A., Harjanne, A., Nurmi, V., Pilli-Sihvola, K., Heyndricx, C., Stahel, A., 2013b. Sector specific and generic impacts of enhanced weather and climate services in a changing climate (ToPDAd Deliverable 2.2).

Monday session – Limits and opportunities

Tailoring climate services for impact challenges in municipalities in Northern Norway

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Hege Hisdal; Norwegian Water Resources and Energy Directorate
Hans Olav Hygen; Norwegian Meteorological Institute

Northern Norway is no exception in a world facing global warming. Global climate models indicate that the global warming is enhanced in these northern regions, and downscaled projections indicate an increase in annual temperatures of ca. 3 °C during this century. Annual precipitation and extreme daily rainfall are projected to increase ca. 20%. These changes imply a strong need for climate adaptation. The Norwegian Meteorological Institute (MET Norway) and the Norwegian Water Resources and Energy Directorate (NVE) have initiated a Climate Service Center focusing on serving the municipalities and decision makers in Norway. A pilot study was established, to identify the needs for climate and hydrological information in selected municipalities in Northern Norway, and how to integrate this information in the planning procedures of the municipalities. This project is a cooperation between the Directorate for Civil Protection and Emergency Planning, NVE, MET Norway and the County Governor of Troms. The focus area includes the city of Tromsø, and the three rural municipalities Lyngen, Balsfjord and Målselv. The project was led by the County governor of Troms, which ensured a strong user driven process, with needs of the municipalities driving the process. The role of the scientific partners, NVE and MET Norway, has been to adapt the format of the climate information to the municipal needs. A key finding is the need to bridge the gap between research output and the operational needs of the municipalities in climate change adaptation. The selected municipalities have identified substantial challenges in preparing for future as well as present climatological and hydrological extremes. Major issues include river flooding, urban runoff, avalanches, landslides, sea level rise and wind exposure. Much of the needed data is not available, and much of the information available is not applicable in its present form. A major challenge in the project is to establish methods to extract information from scientific results about changes in climate and hydrology that can be used in the municipality planning processes at different levels of detail. The project has tried to achieve the bridge between the scientific understanding and municipal needs through the development of two products: Klimahjelperen (The climate helper) and Klimaprofil Troms (Climate profile of Troms). The climate helper focus on how the municipalities easily can include the climate adaptation in their daily tasks, and the climate profile gives a short summary of the knowledge of the regions climate challenges, expected changes and available information.

Serving adaptation through innovation in weather and climate services

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Väinö Nurmi; Finnish Meteorological Institute (FMI)
Karoliina Pilli-Sihvola; Finnish Meteorological Institute (FMI)
Atte Harjanne; Finnish Meteorological Institute (FMI)

Improved information provision is a crucial building block of adaptation, also for infrastructure systems. . Innovation in weather services will help to smoothen the adaptation process, while lowering its cost. This process is discussed, analyzed and illustrated in this contribution. Reviews of climate change induced aggravation of risks for various types of infrastructure provide mixed messages (Przyluski et al 2012; Koetse & Rietveld 2009) depending on the considered modes, area, time frame, technology development and economic growth. Such situations call for caution regarding significant specific investments, since the uncertainty about the adequacy is large, which in combination with investment specificity means notable risks for stranded costs. In such cases stepwise improvements so as to maintain option values, while still immediately reducing damage costs, is an attractive approach. Weather and climate services (WCS) play an important role for enhancing coping ranges of infrastructure systems with respect to adverse weather. Ongoing innovation in WCS has resulted in a steady increase of the reliable forecast period (1 day extra per decade, Nurmi et al 2013). Recent research (e.g. Perrels et al 2013a) illustrates that innovation of WCS should be extended to the entire weather service chain (including forecasting, information tailoring, media choice, access, comprehension, leeway for response, benefit retention) in order to maximize the leverage of the improvement efforts. By linking innovation not only to planned adaptation, but also to automatic adaptation the eventual cost of adaptation to climate change may be lower than otherwise would be the case (Perrels et al 2013b). In the FP7 TOPDAD project (http://www.topdad.eu/) enhancement of automatic adaptation through promotion of innovations is explored. Identification of expected innovations up to about 2030 was done by means of 30 semi-structured interviews of relevant stakeholders across Europe, representing various types of infrastructure, WCS providers, and technology providers and developers. This was supplemented by a literature review. The identification process during and after the interview was assisted by the Weather Service Chain Analysis (WSCA) classification, which distinguishes 7 steps in the weather service chain. Subsequently we review the benefit potential of WCS innovations by means of WSCA and infrastructure scenarios. Notwithstanding the innovation boosting effect of open data policies, key innovations in WCS will depend to a large extent on public funding due to the significant share of infrastructure with a public good character. The key drivers for innovations in weather and climate services are: the reduction in unit-cost of measurement, observation and data-exchange - it enables higher spatial resolution projections and responsive tailored mobile services; integration of networks and data types, enabling further improvement of projections; third party access to public observation and modelling data broadens innovation capacity; An intelligent road weather system would generate annually just in Finland about 30 million euro net benefits from avoided accidents in winter. It also reduces logistic costs.

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Adressing the climate adaptation deficit through geographic visualization

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Tina Simone Neset; Linköping University
Tomasz Opach; Norwegain University of Science and Technology
Jan Ketil Rød; Norwegian University of Science and Technology

This presentation explores the role and potential of geographic visualization for assisting decision-making and supporting implementation of climate change adaptation. Interviews and group discussions with planners and decision makers indicate that besides analytical functions, geographic visualization bears primary potential for communicative purposes. We conclude that rather than better climate predictions, awareness and involvement may be precisely what is needed to narrow the implementation gap in climate change adaptation. This presentation explores the role and potential of geographic visualization for assisting decision making and supporting the implementation of climate change adaptation. A group of Norwegian stakeholders working with climate change adaptation and risk management at local, regional and national levels were asked to assess the potential of two geographic visualization tools for supporting adaptation actions and planning decisions. More general challenges to climate change adaptation raised by the stakeholders were partly related to data content and knowledge gaps. Of equal importance however, were ?governance aspects? such as inter municipal cooperation and external as well as internal communication. Our stakeholders saw the primary potential of the visualization tools in spurring dialogues and mobilizing support for adaptive action. More than being beneficial for analytical purposes and functioning as decision support per se they suggest that the visualization tools can assist the implementation processes by helping them communicate the impacts of climate change, raising awareness and mobilizing support for adaptive action. This conclusion corresponds to more general trends within the field of science communication where there has been a move from a focus on information transfer towards the need for public engagement. Our study confirms that visualization tools are helpful for creating engagement and can facilitate social learning. According to our stakeholders, this may also be precisely what is needed to improve decision-making processes and speed up adaptive action. This follows from the recognition of decision making and implementation as being more than a value-neutral and a technical administrative process. Instead it involves several actors with competing views and agendas. As this study has shown, decision making is also about making one?s voice heard, and here visualization tools provide powerful instruments for communication. Therein, we argue, lays the primary contribution of geographic visualization for narrowing the implementation gap in climate change adaptation. Our stakeholders considered the tools as helpful for communicative rather than analytical purposes and suggested that their primary potential lies in spurring dialogues and mobilizing support for adaptive action. Recognizing that implementation may be more than a value neutral and technical administration process, the study argues that rather more exact climate predictions, awareness and involvement may be precisely what is needed to narrow the implementation gap in climate change adaptation.

kjkjh

Effective climate change risk communication

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Measures taken as well as those not taken to respond to climate change affect benefits and risk to the society. Studies have shown personal assessments of risk to be decisive in responding to climate change (Blennow and Persson 2009; Blennow et al. 2012). Most agricultural land and approximately half of the forest land in Europe is privately owned. Often the land owned by one individual is used for different purposes, such as agriculture, grazing and forest. Since the land provides crucial services and benefits such as food, fiber, fuel, nature experience, and recreation, every resident has a stake in the land and how and for what purposes it is used. An understanding of, and respect for, personal risk assessments is therefore important for effective risk communication. How then to communicate climate change risk? Based on recent results from studies on forest-owner adaptation to climate change across Europe (Blennow et al. 2012), an approach to risk communication that is effective as well as ethically sound (Blennow et al. 2014) is presented and exemplified. Knowledge of heuristics and mutual information on both beliefs and desires are important in the proposed risk communication approach. Such knowledge provides an opportunity for relevant information exchange, so that gaps in personal knowledge maps can be filled in and effective risk communication can be promoted.

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Remote sensing estimates of impervious surfaces for pluvial flood modelling

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This paper investigates the accuracy of medium resolution (MR) satellite imagery in estimating impervious surfaces for European cities at the detail required for pluvial flood modelling. Using remote sensing techniques enables precise and systematic quantification of the influence of the past 30-40 years of urban development towards the impacts of high-intensity rainfall In recent years, it has been demonstrated that cities globally have become increasingly exposed to the impact of pluvial flooding (Field et al., 2012). There is evidence that the observed change in risk may have been caused by a combination of large increases in the extent of urban cover and climate change (Field et al., 2012) (Angel et al., 2011). Urban environments are dominated by impervious surfaces (IS), which are sealed areas through which water cannot penetrate, as road infrastructure, buildings and other paved areas occupy a main share of the urban land area (Weng, 2012). Hence impervious surfaces are often used as an indicator of urbanization. Changes in the quantity of impermeable surfaces (IS) have important implications for the hydrological response of a catchment. Replacing natural land cover with artificial surfaces causes a reduction in infiltration capacity and surface storage capacity (Butler, 2011)(Parkinson and Mark, 2005). Water moves faster over sealed surfaces than over natural surfaces, and high IS cover subsequently increases run-off volumes, peak flows and flood frequency. MR satellite imagery offer a complete spatial and temporal coverage of global urban land cover changes during the past 30-40 years, and can be used as a basis for accurate quantification of small scale changes in IS. This research addresses the accuracy and applicability of medium resolution (MR) remote sensing estimates of IS fractions, e.g. for urban hydrological modelling. A main objective is to show that NDVI may be an accurate measure of sub-pixel imperviousness for urban areas at different geographical locations, and that it can be applied for cities with diverse morphologies and climatic conditions. For this purpose the accuracy of NDVI based estimates of IS have been examined for eight different cities in Europe at 30m and 60m spatial resolutions. The impervious surface fractions are estimated using pixel- based Ordinary Least Squares (OLS) regression models between Landsat 8 Maximum Value Composite (MVC) NDVI and actual imperviousness, which is measured manually from high resolution images. The potential spatial transferability of the city-specific regression models was addressed by examining the homogeneity of the models. This was done by quantifying the absolute mean errors and biases between all possible combinations of regression models and urban areas. The results of the accuracy assessment show that the absolute mean errors of the NDVI based IS estimates are 6-11% and 5-9% for the analyses with 30m and 60m spatial resolutions respectively. The low variability in accuracies across geographical locations suggests that an equally strong relationship between NDVI and IS fractions exists for many other urban areas, both within and outside of Europe. The findings indicate that MR satellite imagery can provide accurate estimates of the quantity and location of IS and changes herein, for cities at different geographical locations, and at the detail required by pluvial flood models.

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Special session: Centre for Regional Change in the Earth System

Centre for Regional Change in the Earth System: models, uncertainties, effects and adaptation

Jens Hesselbjerg Christensen (Danish Meteorological Institute) and the CRES team

Adapting to climate change requires a common understanding and quantification of how human activities, interacting with natural processes, affect human and natural systems. The Centre for Regional Change in the Earth System (CRES) is a five year funded multidisciplinary climate research platform financed by the Danish Council of Strategic Research. It brings together leading scientists with excellent and long track records of quality research in climate change and key Danish stakeholders and practitioners with a need for improved climate change information.

CRES carries out a number of specific research activities, all tied together with a common agenda taking an interdisciplinary approach. The overall objective of CRES is to extend knowledge on and reduce the uncertainties surrounding regional climate change and its impacts and thereby support future climate change adaptation and mitigation policies. While more specific objectives are to: a) reduce uncertainty surrounding regional climate change and its impacts for the period 2020-2050 by improving model formulation and process understanding; b) identify key changes and tipping points in the regional hydrological system, agriculture, freshwater and estuarine ecosystems caused by changes in seasonality, dynamics and extreme events of precipitation, droughts, heat waves and sea level rise; c) quantify confidence and uncertainties in predictions of future regional climate and its impacts, by improving the statistical methodology and substance and by integrating interdisciplinary risk analyses; d) interpret these results in relation to Danish, European, and global risk management approaches for climate change adaptation and mitigation.

Since the start of CRES in October 2009, scientific advancement has taken place with respect to each of these specific objectives. A large number of scientific papers have resulted from this and has in many cases substantially lifted the scientific foundation that underpins decision making with respect to climate change adaptation. With CRES, one may argue that advancing the underlying scientific understanding of issues central for decision making particularly in Denmark has gone hand in hand with the need to communicate the state-of-the-art in addressing these issues. An emerging theme already pertinent to CRES activities is to take a risk based approach towards understanding climate change impacts and when considering practical adaptation options and strategies.

This presentation will highlight both some of the scientific achievement as well as how these have been communicated to the users of climate change information needed in adaptation work as well discussing how the remaining efforts within the lifetime of CRES are expected to kick-off the next stage in defining how climate change science meets societal needs related to adaptation.

Risk Based Approach to the Assessment of Economic Consequences of High End Climate Scenarios – Methodological Framework and Application to Urban Flooding

Kirsten Halsnæs, Per Kaspersen, and Martin Drews; Technical University of Denmark

A development pathway towards higher-end climate change scenarios is expected to increase the probability of climate events, which can be associated with extreme economic consequences. This reflects that a stronger climate signal is likely to change the probability distributions of high impact events related to e.g. temperature, precipitation and wind storms both in terms of the intensity, frequency and variability. Some of these extreme events, which are likely to be pronounced under the higher end of global warming scenarios, will impose risks on key assets including i.e. ecosystems, human settlements, infrastructure, land use sectors, coastal areas, and water systems. Inspired by Martin L. Weitzman: Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change, we present a methodological approach for the assessment of extreme economic consequences of climate events with low probability, but high consequences. The approach is discussed in the context of conventional cost benefit analysis applied to climate change risk assessment, where expected values of damages are a key parameter. Differently, the paper suggests explicitly to consider a more complete probability density function for extremes, and to address how such probabilities potentially could develop over time as higher atmospheric stabilization arrives. The probability estimates subsequently are coupled with damage estimates in an integrated risk assessment, where alternative assumptions about substitution of different welfare impacts and risk aversion indexes are included. The methodological framework and alternative assumptions are applied to a local case study in Denmark considering the risks of urban flooding in a large Danish city, where various assets including health, building, infrastructure, historical buildings, and ecosystems are at risk.

Evaluating the future impacts on Odense catchment under climate and land use change

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The future is inherently uncertain and this also applies to evaluating how ecosystem goods and services at the landscape and catchment scales will be affected by human activities. The land area in Denmark is dominated by agriculture, which occupies more than 60% of the land surface, and most of this area is in intensive cereal farming supporting livestock production of both pigs and dairy. This productive landscape supplies agricultural products for export, but is also associated with environmental problems, such as nitrate leaching causing eutrophication in freshwater and marine ecosystems. The nitrate leaching is greatly affected by the land use, the types of crops grown and the intensity of the production, as well as by temperature and rainfall patterns that influence soil organic matter turnover and water flows in the soil, groundwater and surface water systems and thus transports excess nutrients from agricultural land to the streams and marine areas.

The CRES project analyses the impacts of different factors affecting hydrology, nitrogen cycling and nitrate leaching and transport at the catchment scale for an upstream sub-basin of Odense catchment in Denmark. The catchment scale modelling study involves two separate sets of catchment scale models: 1) the Daisy crop model coupled to the MIKE SHE distributed hydrological model, and 2) the SWAT integrated catchment model. These models were calibrated for current land use and climatic conditions of the Odense catchment, in particular for stream runoff, harvested nitrogen in crops and nitrogen transported in the stream. The models were subsequently applied to scenarios of land use change and climate change. Four different land use change scenarios were developed and summarised under the following headlines: 1) Agriculture for nature (reduced agricultural area and less livestock), 2) Extensive agriculture (reduced intensity in agriculture and less livestock), 3) High-tech agriculture (higher productivity in agriculture but less agricultural land), and 4) Market driven agriculture (increasing agricultural area and higher intensity). This land use scenarios were translated into geographically specific changes in land use and management. The land use changes were combined in scenario runs with climate changes for 2050 and 2090 by using downscaled outputs from four different GCM-RCM coupled model runs under the SRES A1B emission scenario: ECHAM5 – HIRHAM5, ECHAM5 – RCA3, ARPEGE – RM5.1 and HadCM3 – HadRM3. The results thus focus on addressing the uncertainties of future hydrology, agricultural productivity and nitrate leaching and transport as affected 1) land use, 2) climate change as addressed by different future time slices and climate models, and 3) catchment scale impact model.

A model validation framework for climate change projection and impact assessment

Madsen, Henrik; DHI; Refsgaard, Jens Christian; Geological Survey of Denmark and Greenland (GEUS); Andréassian, Vazken; IRSTEA; Arnbjerg-Nielsen, Karsten; Technical University of Denmark; Davidson, Thomas; Aarhus University; Drews, Martin; Technical University of Denmark; Hamilton, David; University of Waikato; Jeppesen, Erik; Aarhus University; Kjellström, Erik; Swedish Meteorological and Hydrological Institute; Olesen, Jørgen E.; Aarhus University; Sonnenborg, Torben; Geological Survey of Denmark and Greenland (GEUS); Trolle, Dennis; Aarhus University; Willems, Patrick; KU Leuven; Christensen, Jens Hesselbjerg; Danish Meteorological Institute

Models used for projection of climate change and its impacts are usually not validated for simulation of future climate conditions. This is a serious deficiency that introduces an unknown level of uncertainty in the projections. A framework and guiding principles are presented for testing models using proxies of future conditions. In general, a model that has been setup for solving a specific problem at a particular site should be tested in order to document its predictive capability and credibility. In a climate change context such tests, often referred to as model validations tests, are particularly challenging since the model is used for an unknown future with a climate that is significantly different from current conditions. Most model studies reported on projections of climate change and its impacts have not included formal model validation tests that address this issue. A model validation framework and guiding principles for testing the capabilities of models for projection of climate change and its impacts have been proposed by Refsgaard et al. (2014). This framework is based on the hierarchical test scheme for model validation developed by Klemes (1986), which distinguishes between model predictions performed under stationary (split-sample tests) or non- stationary conditions (differential split- sample test), and if the model is applied at the site where it was calibrated or at a different site (proxy site tests). This model validation scheme has been assessed in relation to use of different methods for projection of climate change (single and ensemble model projections and space-time-substitution) and use of different data sources as proxy for future climate conditions (long historical records comprising non- stationarity, paleo data, and controlled experiments). The basic guiding principles state that: (i) before a model is used for climate change projections and impact assessments it must demonstrate its predictive capabilities using data that reflects the expected future climate, (ii) the validation test must be carried out using data that have not been used for model calibration, and (iii) the validation test must provide evidence on the expected accuracy of the model projections and impact assessments. The most commonly used validation test, the split-sample test, is not sufficient in a climate change context. The differential split-sample test should be applied by using adequate proxy data, reflecting future conditions. This test can be used with both single and ensemble model projections as well as with space-time-substitutions. It is generally expected to be more powerful when applied to a model ensemble than to a single model. Since space-time-substitutions include identification of locations with current climate similar to the expected future climate at the site in consideration, any test with this projection methodology involves elements of proxy site tests. For testing models under non- stationary conditions in a climate change context it is recommended to apply a differential split-sample test using best available proxy data that reflect the expected future conditions at the site being considered. Such proxy data may be obtained from long historical records comprising non-stationarity, paleo data, or controlled experiments. The test can be applied with different projection methods, including single and ensemble model projections and space-time- substitutions.

Klemes, V., 1986, Operational testing of hydrological simulation models. Hydrological Sciences Journal, 31, 13-24. Refsgaard, J.C., Madsen, H., Andréassian, V., Arnbjerg-Nielsen, K., Davidson, T.A., Drews, M., Hamilton, D., Jeppesen, E., Kjellström, E., Olesen, J.E., Sonnenborg, T.O., Trolle, D., Willems, P., Christensen, J.H., 2014, A framework for testing the ability of models to project climate change and its impacts, Climatic Change, 122, 271-282, doi: 10.1007/s10584-013-0990-2.

Evaluating climate change adaptation options for urban flooding in Copenhagen based on new high-end emission scenario simulations

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Lykke Leonhardsen; Municipality of Copenhagen
Henrik Madsen; DHI

Climate change adaptation studies on urban flooding are often based on a model chain approach from climate forcing scenarios to analysis of adaptation measures. Previous analyses of impacts in Denmark using ensemble projections of the A1B scenario are supplemented by two high-end scenario simulations. These include a regional climate model projection forced to a global temperature increase of 6 degrees as well as a projection based on the RCP8.5 scenario. With these scenarios projected impacts of extreme precipitation increase significantly. For extreme sea surges the impacts do not seem to change substantially.

The impacts are assessed using Copenhagen as a case study. For both types of extremes large adaptation measures are essential in the global six degree scenario; dikes must be constructed to mitigate sea surge risk and a variety of measures to store or convey storm water must be implemented as well as new paradigms for city planning to mitigate the impact of change in extreme precipitation risk. For both hazards business-as-usual are not possible scenarios, because large autonomous adaptation will occur in lack of suitable policy-driven changes. Copenhagen has developed an adaptation plan to pluvial flooding that makes the urban areas more robust and reduces the risk of flooding in current climate to a very low level. The economic benefit in the A1B scenario is substantial, and even in the 6 degree scenario the frequency of flooding is not much higher than national recommendations today. The expected annual damage in the six degree scenario will be higher than today because the size and frequency of extreme events will increase.

Plenary – Limits and oppertunities

Limits and Opportunities of Climate Change Adaptation

Stine Bosse; CONCITO

Climate change is inevitable and we must adapt to it. However, while we in the rich Nordic countries can reduce and handle some of the risks of climate change with adaptation, we cannot adapt us out of the problem – especially not when we see it in a global context.

In the World Economic Forum's "Global Risk Report 2014" at least four out of ten risks of highest concern is directly related to climate change: The risk of a global water crisis, the failure of global climate change mitigation and adaptation, greater incidents of extreme weather events and a global food crisis. Several more of the risks of highest concern are indirectly related to climate change, including the risk for profound political and social instability.

We cannot shut our eyes to the basic humanitarian needs of the developing world and the risks of large flows of refugees if these needs are not met. Climate adaptation can reduce some of these risks, but without a timely, ambitious and coordinated effort to prevent these interrelated consequences of climate change, it will challenge our civilization and businesses across the globe.

While many developing countries will be extremely challenged by climate change, developed countries like the Nordic countries have the financial means as well as the knowledge and the tools to adapt to climate change – at least in the short term. We will be hit by more extreme rainfalls and storms, but not nearly as severe as other countries. To us, climate change will be an expensive nuisance. To others, it will be a matter of life or death.

Seen in isolation adaptation to climate change in the Nordic countries is likely to create new economic activity and hence contribute to our economic growth and job creation – especially in the construction sector and the water sector. If it's handled wisely, there can also be synergies with a positive urban development and improved nature protection aiming at making our ecosystems more robust to inevitable climate change.

But the costs of these adaptation activities are expected to be much higher than the costs of climate change mitigation. Rather than planning to use financial resources and workforce on adapting to climate change in the coming century, we should therefore focus on developing and investing in low carbon energy technologies and production methods and dematerialized consumption patterns in the years and decades to come.

In the short term we have no choice but to adapt to inevitable climate changes. Now and on the longer term, however, the biggest opportunities economically, socially and in a global perspective lies in a quick, broad and ambitious climate mitigation effort.

If we don't change, we are bound to be outperforming earlier generations in selfishness and short term thinking.

Stine Bosse is chairman of Denmark's green think tank CONCITO.

Climate change as a driver for paradigm change in urban water management

Patrick Willems; KU Leuven, Dept. Civil Engineering, Hydraulics division

Cities are becoming increasingly vulnerable to flooding because of rapid urbanization, installation of complex infrastructure, and changes in the precipitation patterns caused by anthropogenic climate change. This is partly because of decreasing volumetric rainfall trends in many parts of the world, which might have severe effects on reservoir yields and operational practices. In addition, more frequent and more severe intensity rainfall events can cause substantial urban inundation problems.

For many cities in the world, future projections of climate change impacts on extreme short-duration rain showers and urban drainage show significant increases in the frequency of sewer surcharge, flooding and overflow spills. At the same time, due to the difficulties and uncertainties in climate change impact modelling and analysis on the urban scales, caution must be exercised when interpreting climate change scenarios. These uncertainties can however not be used as an argument for not taking determined actions. Instead, uncertainties should be accounted for and flexible and sustainable solutions aimed at.

Interestingly, climate change serves as a driver for changes in urban drainage paradigm. An adaptive approach has to be established that both provides inherent flexibility and reversibility and also avoids closing off options. Also co-optimizing urban drainage infrastructure with other objectives as well as active learning and involvement will become ever more important to keep our cities liveable in the future.

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Willems, P. (2013a), 'Multidecadal oscillatory behaviour of rainfall extremes in Europe', Climatic Change, 120(4), 931-944

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Willems, P., Olsson, J., Arnbjerg-Nielsen, K., Beecham, S., Pathirana, A., Bülow Gregersen, I., Madsen, H., Nguyen, V-T-V. (2012), 'Impacts of climate change on rainfall extremes and urban drainage', IWA Publishing, 252p., Paperback Print ISBN 9781780401256; Ebook ISBN 9781780401263

Climate-KIC and lessons learned so far

Daniel Zimmer; Director of Innovation, Climate-KIC

Tuesday session 1 – IPCC AR5; so what now?

Ten years of implementing regional climate service

von Storch, Hans; Helmholtz-Zentrum Geesthacht

Regional climate service builds a dialogue between regional stakeholders and regiuonal scientific institutions, allowing the usage of scientific knowledge, and ensuing that needs for knowledge and information are taken up by scientific programs Regional climate service is an effort to build a dialogue between regional stakeholders and regional scientific institutions, to allow the usage of scientific knowledge in societal and economic decision processes, and to ensure that stakeholder needs for knowledge and information are taken up by scientific programs. Thus, regional climate service is mostly on the exchange of knowledge (the capacity to act) and less so on provision of information (mostly numbers). Regional climate servicing is pursued at the Institute of Coastal Research at HZG since the early 2000s; apart of some theoretical work on the limitations and conditions of such an exchange, three efforts have been implemented for building such a dialogue: a) An office specifically dedicated to build contacts and to exchange knowledge, views, needs, limitations with regional stakeholders. This 'Norddeutsches Klimabüro' acts like a 'farm shop' of the Institute of Coastal Research and addresses regional stakeholders, from the general public to agencies responsible for coastal defense and companies dealing with the construction of off- shore activities. b) Knowledge assessment reports aka IPCC but for limited regions, done by the regional climate science community, to determine the state of scientific knowledge, including the agreement and disagreement on issues like sea level rise. Such reports have been completed for the Baltic Sea Region (BACC) and the Metropolitan area of Hamburg. These assessment reports may form a model for further diversification and regionalization the future IPCC process. The usefulness of BACC has been recognized by HELCOM by using it as a basis for its political deliberations, and by the Östersjöfonden awarding its Östersjöprisen. c) Detailed date sets about present climate, ongoing change and scenarios of possible future change (CoastDat). Such data sets, prepared with limited area atmospheric models and, in particular, hydrodynamics models of marginal seas and ocean waves, allow an assessment whether ongoing change is consistent with the expectation of future change (scenarios). It turns out this is mostly so for temperature change, but not so for precipitation change. Regional climate service is mostly on the exchange of knowledge and less so on provision of information. Elements of such service comprise a. Offices dedicated to build contacts and to exchange knowledge, views, needs, limitations with regional stakeholders. b. Knowledge assessment reports aka IPCC but for limited regions by the regional climate science community, which determine the state of scientific knowledge, including the agreement and disagreement on issues. c. Detailed date sets about present regional climate, ongoing change and scenarios of possible future change. Regional climate servicing is pursued at the HZG-Institute of Coastal Research since the early 2000s.

von Storch, 2011: Regional Climate Services illustrated with experiences from Northern Europe. ZfU 1/2011 BACC, 2008: Assessment of Climate Change in the Baltic Sea Basin., Springer Weisse, 2009: Regional meteo-marine reanalyses and climate change projections: Results for Northern Europe and potentials for coastal and offshore applications, BAMS. 90

The rebound- effect: A useful concept in the climate discourse?

Carlo Aall; Western Norway Research Institute

The rebound effect has been presented as a possible explanation why major success is still lacking in trying to curve down the energy use in rich industrialised countries. The paper arguments that this effect also can be applied within the climate change discourse. A main message from the latest IPCC reports is that it is too late to hope for mitigation at such a magnitude that we can avoid the need for adaptation; thus society has to do both. Furthermore, time is also out for managing with adjustments of society ? we have to shift to a discourse of societal transformation in the face of climate change implying that society has to prepare for radical measures on both mitigating and adapting to climate change. Thus, it is important to make close links between climate change mitigation and adaptation in both research and policymaking in order to avoid mal- mitigation and mal-adaptation; that is to avoid mitigation that increase climate change vulnerability and adaptation that increase GHG emissions. The rebound effect has been presented as a possible explanation why major success is still lacking in trying to curve down the energy use in rich industrialised countries; a task which is crucial for achieving the goal of a sustainable development as well as avoiding climate change. Basically the rebound effect refers to behavioural or other systemic responses to the implementation of new technologies or other measures to save energy use. The environmental benefits of any environmental policy measures can under certain conditions be less than anticipated (rebound effect) or even negative (backfire effect). Thus, it is important to get a clear understanding of the rebound and backfire effects. Several authors have tried to sum up the controversies relating to rebound effects of energy policies. Some tend to conclude that the rebound effects are limited and therefore of minor importance. Others conclude that rebound effects are at least of some importance, but they need not result in energy efficiency polices becoming substantially ineffective. Others again state that the rebound effect is significant and challenge the belief that improving the efficiency of energy use will lead to a substantial reduction in energy use. These seemingly contradictory conclusions could stem from applying different definitions of what is meant by rebound effects and the application of different system boundaries in rebound analysis, ranging from direct, via indirect to economy-wide (or macro) rebound effects. Tourism is a sector which is vulnerable to both mitigation policies and climate change. An anticipated radical increase in costs relating to carbon emissions will most likely have a negative effect on tourism travels, and changes in climatic conditions may have a negative effect to many tourism destinations e.g. loss of snow in winter tourism destinations. In this paper I will present concrete examples of mal-adaptation and mal- mitigation currently taking place in tourism development in Norway, and discuss the extent that current theories on rebound effects can contribute in revealing and understanding these relationships in the first place, and in secondly if this also can form the basis for discussing possible policy measures to avoid mal- adaptation and mal-mitigation. Theories on rebound effect might help us understand the lack of success in climate policymaking and to reveal mechanisms of how climate change mitigation and adaptation measures may interfere with each other. Future research should focus on documenting and understanding the nature of mal-mitigation and mal-adaptation taking place within different sectors by means of adopting and adapting theories on rebound effects.

Santarius, T. (2012): Green Growth Unravelled. How rebound effects baffle sustainability targets when the economy keeps growing. Heinrich Böll Foundation and the Wuppertal Institute for Climate, Environment and Energy

The challenge of mainstreaming climate change adaptation actions of Nordic insurers

Lára Jóhannsdóttir; School of Business, University of Iceland

Insurers can act as an early warning system in the way that they signal risks that societies face, including climate- related risks. They are, therefore, one of the critical players in collective actions for dealing with climate change impacts and have for that reason been recognized by the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environmental Programme (UNEP), the United Nations International Strategy for Disaster Reduction (UNISDR), and others (Vellinga, et al., 2001; Wilbanks, et al., 2007). Studies and reports, however, suggest that insurers may be reactive in dealing with climate-related risks, (The Geneva Association, 2009), for instance due to organizational or institutional barriers. The purpose of this paper is to discuss some of the organizational and industrial barriers the Nordic insurance industry is facing with respect to climate change, evident in its lack of strategic direction and actions (Johannsdottir, Davidsdottir, Goodsite, & Olafsson, 2013; Jóhannsdóttir, 2012a, 2012b). The findings suggest that the smaller Nordic insurance companies are sometimes led by people with a short time horizon (3-5 years), while the largest companies look further ahead (10-30 years) (Jóhannsdóttir, 2012b). This means that climate-related risk may be unnoticed when the business horizon is short, and the companies not in a position to act as an early warning system for societies. This gap between insurance companies based on their size should be of concern of the industry; if the smaller companies cannot handle climate-related risk and consequent claims, it will reflect negatively upon the industry as a whole. Institutional barriers are another factor. This relates to the different structure of the insurance sector in different Nordic counties. In Norway, the insurance system is more integrated than the insurance system in Iceland, which can be considered fragmented, as it is comprised of the Icelandic Financial Services Association as well as private insurance companies and public insurance pools that insure different risk factors without close cooperation. The different structure of the aforementioned insurance systems has historical roots, for instance because of different climate conditions. The paper suggest that the effectiveness of this early warning system can be improved if insurers are to be critical players in an effective early warning system mainstreaming climate change actions in the Nordic region.

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Climate predictability beyond traditional climate models

Rasmus E. Benestad; The Norwegian Meteorological Institute
Abdelkader Mezghani; The Norwegian Meteorological Institute

Most projections of local and regional climate change do not make use of all available and relevant information and knowledge. Reliable predictions of local climatic characteristics are often needed in decision-making and the adaptation to climate change. The mainstream approach to predicting local climate change involves downscaling results from a global climate model (GCM) with a regional climate model (RCM). This approach only makes use of part of the available information. An alternative way to provide a description of the local climate is to use empirical-statistical downscaling (ESD), which makes use of an additional and independent source of information: empirical data. However, we argue that past efforts have not made fully use of a third independent available source of information. Statistics provide a valuable theoretical reference frame for validating model results, making sense out of data, and designing statistical models. We propose a combination of these various information sources that will enhance our ability to predict local climate change. To demonstrate this, a strategy for predicting the statistical distribution, frequency of wet-days, and duration of events for 24-hr precipitation is presented. This approach is used to predict heavy precipitation events, both in terms of intensity, and frequency. Results are presented for consecutive wet and dry days and number of events per year exceeding a given threshold. We also propose a strategy for validating and estimating the skill-score of the predictions in terms of relevant figures: the number of intense events per year and number of cases falling outside the 90% confidence interval are assessed using a binomial distribution with known probabilities. Furthermore, we present an assessment of GCMs based on common empirical orthogonal functions (EOFs). All these results are derived using a new freely available open-source R-package (esd) and are a part of the work carried out for projects like EU-SPECS, COST-VALUE, and CORDEX-ESDM. The combination of independent information sources will enhance our ability to make inferences about local and regional climate change, and benefit climate change adaptation.

Work in progress

Multi-model Combination of Statistically Downscaled RCM Projections

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Ditlevsen, Peter; University of Copenhagen
Vrac, Mathieu; LSCE, IPSL, France

We have developed a method for combining an ensemble of statistically downscaled climate models for estimating future changes in rainfall - both average and extreme. By combining the a number of projections the uncertainties in these are better estimated. As technology improves more and more ensembles of climate models are used in projections. Often the use is limited to ensemble averaging, but multiple efforts have tried a bayesian approach to combining ensembles e.g. Smith (2009). Very few efforts have used statistically downscaled projections. We propose a method to combine downscaled projections of present and future rainfall inspired by Chandler (2013). Using a bayesian framework on an ensemble of statistically downscaled regional climate models, we illustrate how to combine them in to one projection for future rainfall with uncertainties. The regional climate models are 4 8x8 km 30 year runs driven by global circulation models on 1981-2010 and 2071-2100. Our main focus is to estimate the uncertainty in future projections and the bayesian framework provides that. Using this method we are able to combine several methods of statistical downscaling in to one projection for future rainfall. This method also has applications to other uses of model ensembles.

Bayesian Modeling of Uncertainty in Ensembles of Climate Models, Smith et al (2009) Exploiting strength, discounting weakness: combining information from multiple climate simulators, Chandler (2013)

Tuesday session 1 - Mainstreaming

Control Station 2015 - Swedish Adaptation to Climate Change

Andersson, Lotta; Swedish Meteorological and Hydrological Institute
Bergström, Sten; Swedish Meteorological and Hydrological Institute
Boman, Anna; Linköping University
Ohlsson, Alexandra; Swedish Meteorological and Hydrological Institute
Persson, Gunn; Swedish Meteorological and Hydrological Institute
Van Well, Lisa; Swedish Geotechnical Institute

Presentation of a Swedish Governmental Mission on survey of climate adaptation actions and knowledge generation since 2008 and suggestions of prioritized new actions. The work involves national and regional authorities, municipalities, sector organizations and various experts and aims to be used for update of Swedish governmental climate adaptation actions. The Swedish Meteorological and Hydrological Institute (SMHI) has been given the governmental mission to coordinate an assessment of the development of climate adaptation actions, as well as to make an overview of new knowledge of relevance for implementation of adaptation actions since the launch of the Swedish government´s climate proposition in 2008 and to suggest further actions. The climate proposition has a strong focus on mitigation but does also include climate adaptation, although no specific goals and visions are given. The proposition is referred to as the Swedish Climate Adaptation Strategy. The work, that was initiated in January 2014, involves relevant Swedish National authorities, as well as county boards, municipalities and sector organizations representing, e.g., insurance and water utilities. Consultation is also made with researchers and other experts. A number of workshops are arranged to ensure that various views are considered. Although it still not is completely clear how the report from the ongoing mission will be used, the rationale behind it is to assist the political processes in the further development of the Swedish Climate Adaptation Strategy. Suggestions of prioritized actions will be based on identified needs on the local, regional and national level, with emphasis on integration between levels as well as between sectors. In addition, suggestions will consider the EU scoreboard on climate adaptation, as well as the need for regional cooperation, e.g. based on the recently launched Climate Adaptation Strategy for the Baltic Sea Region. Special emphasis is also on the indirect impacts in Sweden from climate change impacts in other parts of the world, as well as on a review of what Sweden can learn from other countries, with emphasis on how to facilitate climate adaptation on the local level. This presentation will provide preliminary conclusions from the knowledge update as well as from the survey of what has been achieved since 2008 related to climate adaptation. It will also give some indications of what the suggested prioritized actions might be. However, the final document will not be delivered to the Swedish Government until the end of 2014. The preliminary findings show the need for an integrated perspective on climate adaptation with clear roles identified on and between all levels, and cooperation between sectors to ensure synergies and avoid mal adaptation related to, e.g., environmental impacts or impacts on cultural assets. Increased knowledge related to processes for climate adaptation on all levels from national planning to the individual are called for, as well as increased access to economic evaluations. The need to address adaptation with a global perspective is addressed, as well as the need to relate national adaptation to EU and other international policies,

Miljödepartementet, 2008. En sammanhållen klimat- och energipolitik - Klimat Prop. 008/09:162 (In Swedish)

A climate adaptation strategy for the Baltic Sea Region

Maxi Nachtigall; Council of the Baltic Sea States, CBSS Baltic 21

Both the EU Strategy on Adaptation to Climate Change & its Council Conclusions emphasize the importance and value added of cooperation and knowledge exchange between member states. Within the framework of the EUSBSR, a macro-regional CCA-strategy has been developed. A well- established project to policy process seeks its further implementation. In the Chairman?s Conclusions of the 7th Baltic Sea States Summit in Riga, 2008 the Heads of Governments ?encouraged the Council of the Baltic Sea States and its strategic partners to pay special attention to climate change in the region? [?]. Both the EU Strategy on Adaptation to Climate Change and its Council Conclusions emphasize the importance and value added of cooperation, knowledge and good practice exchange between member states, regions, cities and other stakeholders. The EU Strategy for the Baltic Sea Region, called for a macro-regional CCA strategy. As horizontal issue, climate change (adaptation and mitigation) is also dealt with under the EUSBSR Horizontal Action Sustainable Development. CBSS-Baltic 21 as leader of this action has taken a central role to ensure coherent joint policy development and capacity building in this field across the whole Baltic Sea Region, including Russia. The EU financed CBSS-Baltic 21 Lighthouse and EUSBSR flagship project Baltadapt that developed a transnational climate change adaptation strategy for the Baltic Sea Region in a unique integrated cross-sectoral project to policy process. The 16th Council of the Baltic Sea States? Ministerial Session in June 2011 welcomed the efforts underway to develop a climate change adaptation strategy for the Baltic Sea Region. Since 2013 this strategy is in the hands of member states and the leader of the EUSBSR Horizontal Action Sustainable Development, CBSS-Baltic 21 for further action on policy level. CBSS-Baltic 21 arranged two climate change adaptation round tables in the Baltic Sea Region in December 2013 and April 2014 in Sweden and Poland. Within this framework member states expressed their wish to establish a climate dialogue platform for the Baltic Sea Region. Cooperation between member states, sub-regions and relevant pan-Baltic players, including on knowledge sharing and transfer as well as on capacity building and policy mainstreaming, must be promoted. The Baltic Sea Region Climate Dialogue Platform aims to contribute to the implementation of the Council of the Baltic Sea States decisions as well as the EU climate policies and promote cooperation in the area of climate change adaptation, inform policy development, catalyze exchange of information, best practices, foster synergies among existing initiatives, explore further cooperation opportunities and contribute to the identification and development of concrete joint initiatives based on the conclusions and recommendations of the macro-regional climate adaptation strategy. Awareness and preparedness to climate change differ immensively across the Baltic Sea region. Macro-regional cooperation, i.e. within the framework of the EUSBSR allows for coherent policy development on climate change beyond national borders. It can only be successful if policy development is designed as an integrated cross-sectoral multilevel governance process where member states show political will and a proactive cooperation approach. Climate change requires mainstreaming across sectors and policies as well as coherent cooperation across all levels of governance. Pan-Baltic organizations have to play a critical role in this respect.

www.cbss.org/environment-and- sustainability/eusbsr-hasd/ An EU Strategy on adaptation to climate change, COM(2013) 216 final; An EU strategy on adaptation to climate change - Council conclusions (11151/13); Declaration of the 16th CBSS Ministerial Session, Oslo, 7th June 2011 Declaration on the reform of the CBSS, Deputy Ministers meeting, Riga, 3rd June 2008

The 2nd Generation National Adaptation Strategy ? Improvement or Regression to the Mean?

Mäkinen, Kirsi; Finnish Environment Institute
Hildén, Mikael; Finnish Environment Institute

In 2005 Finland adopted one of the first national adaptation strategies in the world. A new strategy is to be adopted in spring 2014. The 2nd generation strategy differs in extent and approach from its predecessor. This paper analyses the differences and discusses if the evolution improves implementation of adaptation. The 2005 Finnish adaptation strategy ambitiously covered ?all? sectors and included suggestions for proactive and reactive actions. It led to action programmes (Ministry of Agriculture and Forestry, Ministry of the Environment), or references to adaptation in other operational programmes (Ministry of Transport and Communication, Ministry for Foreign Affairs). Some Ministries did not specifically deal with the topic. An evaluation in 2009 found that awareness of climate change and recognition of the need for adaptation measures had developed, with some sectors progressing to identification and implementation of practical measures. Some sectors had remained at an early stage of implementation suffering from an ?implementation deficit?, which Dupuis & Knopfel (2013) explain by issues such as resistance to transformational measures and inter-policy conflicts. The evaluation recommended that implementation of the strategy should be strengthened by increasing climate awareness among policymakers at all levels, directing resources to adaptation research and by supporting cross-sectoral collaboration. In 2012 work was initiated to revise the strategy, starting with an evaluation focusing on the period after 2009. The evaluation found that while adaptation had progressed in all sectors since 2009, several areas still needed strengthening in order to support adaptation. Key recommendations included further integration of adaptation in sectors whilst considering sector-specific and regional factors. This would lead to flexible policy instruments for adaptation, practical methods and tools for risk assessment and management, stronger horizontal and vertical coordination, support for autonomous adaptation, and research responding to societal needs. The evaluation called for more systematic assessment of adaptation needs and measures in all sectors, as well as improved monitoring of the strategy?s implementation. A new draft strategy was published in March 2014 and sent out for consultation. By analysing the draft strategy and the responses it has invoked, we examine a crucial question: can the evolution of the strategy overcome implementation deficits or will the difference grow between sectors that progress and those that do not? The draft strategy is very different in form from the old one. While the 2005 strategy aimed at identifying concrete actions, the new strategy is primarily a broad policy document. Rather than focusing on impacts, vulnerabilities and adaptation measures in different sectors, the new draft strategy focuses on broader measures supporting integration of adaptation in all sectors and levels of administration. This suggests a strong belief in policy integration but the strategy does not, as Dupuis & Knopfel argue it should, emphasise results. Evolution of the Finnish adaptation strategy has led to a partial reframing of adaptation: vertical expansion towards the local level and the international level, move from vulnerability towards managing climate risks, more explicit responsibilities for sectors, emphasis on cross-sectoral measures, communication and monitoring, and more directed research. This reframing may partly address the implementation deficit without focusing on results. It may, however, not be sufficient for overcoming the inertia of sectors that only pay lip service to adaptation. Increased attention to incentives for action rather than a focus on outcomes may be the next necessary evolutionary step for adaptation strategies.

Draft National Strategy for Adaptation to Climate Change 2022 (2014) Dupuis & Knoepfel 2013. The adaptation policy paradox: the implementation deficit of policies framed as climate change adaptation. Ecology and Society 18(4):31. Evaluation of the Finnish Adaptation Strategy (2009, 2013) Finland?s National Strategy for Adaptation to Climate Change (2005)

Localizing the Governance of Climate Change

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Existing governance models for climate change adaptation very much rely on top down approaches. Yet the localization of measures and their communication is needed to implement them more effectively. The historical and cultural background plays an important role here. Climate change adaptation is becoming increasingly important with the failure of the implementation of international policies to prevent the emission of greenhouse gases. The anticipated changes of the climate raise several problems for cities and local authorities which are being addressed in national programs. Yet these programs sometimes fail to reach their recipients. This paper hypostasizes that the difficulties result from a communication problem, which finally boils down to be a governance issue. The reflection of top- down implementation processes and inclusion of locally specific knowledge leads to a more suited approach helping to involve stakeholders on an urban level, making their knowledge profitable for adaptation and legitimization of climate change adaptation measures. Fitting existing governance models to both local narratives and knowledge will contribute to making climate adaption measures more effectively. Drawing from an empiric study of German coastal cities this paper exemplifies possible models of ?best practice? governance models. The results are based on a three-year research project, utilizing a discourse analysis to explore the historical genesis of local knowledge and qualitative expert interviews to comprehend actor knowledge and network constellations. Which strategies can be utilized to bring scientific, political and local knowledge together in order to meet the specific local needs and constellations? While no one-fits-all model can be given for every city, we could identify factors determining the effectiveness of measures in areas like public communication, participation, institutionalization et cetera. The paper shows how to improve local governance processes by integrating the elements of local knowledge and networking strategies into existing policy models. The outcome will hopefully help actors in politics, administration and civil society to act more efficiently and adequately to future challenges.

Climateadaptation.eu: connecting science and end-users on climate adaptation across Europe

Ten Brinke, Wilfried; Blueland Consultancy / Centre for Climate Adaptation

The website www.climateadaptation.eu aims to serve as an interface between science, decision-making and practice in Europe by creating overview and interpreting information on climate change, impacts, vulnerabilities and adaptation strategies. The website summarizes key findings on climate adaptation for all European countries and all relevant sectors. Adapting to the consequences of climate change is in the interest of all of us. All sections of society are end-users of scientific research on climate change impacts, vulnerabilities and adaptation strategies. The outcomes of scientific research on climate adaptation should be accessible to a wide audience. Scientists should be familiar with the type of scientific information that end-users and decision-makers need. Bridging the gap between producers and end-users of (scientific) knowledge, however, has been, and continues to be a major challenge. The continuous gap between science, policy-making and practice is partly due to the fact that scientists are not focused on publishing for a wide audience, in low impact factor trade journals or industry magazines, whereas end-users are not familiar with the terminology that scientists use. This issue has been repeatedly identified as a major source of disconnect between science and end-users, and even a barrier to climate change adaptation (Kiem and Austin, 2013). Making information available does not equal making information accessible. Information is made available on several websites. Bulky reports can be downloaded. It may be questioned, however, whether the information in these reports really reach the target groups. The latest research results may be hard to find or come by (most target groups do not have access to scientific journals). The scientific language will be hard to understand. And those who start a journey on the internet to find the information they need will be confronted with an overload and wonder: where do I start? In this respect, the state-of-the-art reports of the IPCC, or even the summaries for policy makers, are hardly a helping hand: the language and illustrations are generally too complicated for non-scientist target groups. Stakeholders need more guidance to find their way through the information jungle. Innovative solutions are needed to interface between science, policy-making and practice. Interfacing is a discipline by itself. It calls for understanding science, knowing the information needs of end-users, and being able to communicate scientific results to a wide audience. The website www.climateadaptation.eu aims to serve as an interface between science, decision-making and practice in Europe by creating overview and interpreting information on climate change, impacts, vulnerabilities and adaptation strategies. The website summarizes key findings on climate adaptation for all European countries and all relevant sectors. The website helps those who are searching for a quick, but well-substantiated summary of the impact of climate change and strategies to deal with it in their country or their field of interest. Stakeholders, therefore, don?t need to invest a lot of time in reading complicated and bulky reports: this has been done for them. They can rely on the information because the references to all the publications are conveniently arranged.

Kiem, A.S. and E.K. Austin, 2013. Disconnect between science and end-users as a barrier to climate change adaptation. Climate Research 58: 29?41.

Tuesday session 1 – Low probability / high impact

Sustainable primary production in a changing climate - effects to barley and oilseed rape from the future climate

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With the present increase in the emission of greenhouse gasses, the future environment for crop cultivation will change substantially. New crop cultivars and disease control strategies are demanded. We mine existing genetic resources for genotypes and genes providing resilience to the effects of climate change. We analyzed the effects in barley and oilseed rape from the future climate change. In a climate phytotron (RERAF, DTU-Risø) future climate scenarios were applied to 138 accessions of barley and 32 accessions of oilseed rape. Production parameters were recorded in the different climate scenarios that represented elevation of single abiotic factors - [CO2], [O3] and temperature - and combinations of the abiotic factors. In a separate study it was examined, how the climate scenarios are affecting resistance to the fungal diseases spot blotch and powdery mildew. Production parameters and abundance of diseases were also evaluated under field conditions in a Free Air Carbon Enrichment facility. Both for barley and oilseed rape the seed yield was significantly reduced in treatments with +5 ?C above ambient. When the [CO2] was increased together with the temperature the yield deficit was reduced, but yield was still lower than in the ambient treatment (barley -30 %, oilseed rape -10 %). Large differences among accessions were recorded. Based on their environmental stability (Si2 and Wi2) some of the accessions could be identified as environmentally resilient, why they may serve in the breeding of cultivars for tolerance to future environmental variation. In an association mapping of the barley accessions, 118 SNP markers were found to link to production parameters recorded in the 5 different environmental treatments. When growing under elevated temperature or [O3], infection by the biotrophic powdery mildew fungus decreased, whereas disease symptoms and growth of the toxin secreting hemibiotrophic spot blotch fungus increased compared to ambient conditions, implying that climate induced changes in disease severity could be linked to the trophic lifestyle of the pathogens. Combination of the climatic factors affected the diseases in an unpredictable non-additive manner, emphasizing the importance of conducting multifactorial experiments, when evaluating the potential effects of climate change. Enriched CO2 atmosphere in the field increased biomass and yield and decreased severity of powdery mildew supporting the phytotron results. Life Cycle Assessment partly based on primary data from the phytotron, indicated which focal points should be of interest to future strategies for a sustainable primary production in a changing climate. We have found high yielding genotypes with resilience to a number of future climate changes. Not only crop productivity but also quality is affected under climate change. We have identified DNA markers for genes of importance to high primary productivity under climate change. Life Cycle Assessment has pointed to key factors that should be focus points, when strategies are implemented to ensure a future sustainable production in a changing climate.

Climatic changes of extreme precipitation in Denmark from 1874 to 2100

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Karsten Arnbjerg-Nielsen; DTU Environment

This study presents the results of a coordinated effort to estimate past, present and future changes and uncertainties in Danish design rainfall for urban drainage systems. The performed analyses cover long historical precipitation records, observations from a high-resolution rain-gauge network, an ensemble of climate model simulations, and two high-end climate scenarios. During the past 30 years rather dramatic changes in extreme precipitation have been observed in Denmark. These changes are mainly in the frequency of extreme events, but there is also a tendency towards more severe events. Both are considered effects of anthropogenic climate change. The increase in precipitation extremes has led to inundations in most of the larger cities during the last 10 years. To establish cities that are resilient to pluvial floods, robust projections of the frequency and intensity of extreme precipitation events in a changing climate are needed. Additionally, it is equally important to understand the natural variation onto which the anthropogenic changes are imposed. Trend analysis of observations from the high-resolution rain-gauge network currently applied for estimation of design intensities shows that the frequency of extreme events has increased by approximately 2% per year during the last three decades. Additional analyses of five long daily precipitation series show that the frequency of extreme events in the past has oscillated with a cycle of 25-35 years, a behavior that can in part be explained by sea level pressure differences over the Atlantic. On this basis the precipitation extremes in the Eastern part of Denmark are projected to be ascending in the last two decades. However, the increase has continued longer than expected and with larger amplitude in the most recent years. This indicates a likely influence from anthropogenic greenhouse gas emissions. With the complex combination of general increase and natural variation several additional years of observation are needed before this hypothesis can be evaluated by statistical means. Extensive analysis of 17 different regional climate model (RCM) simulations shows that anthropogenic activity very likely will contribute to a significant increase in extreme precipitation amount and occurrence in Denmark. It is argued that climate models are incapable of simulating extreme precipitation at the temporal scales relevant for evaluation of the urban pluvial inundation risk. Hence different statistical downscaling methods have been applied. Furthermore, the effect of the emission scenario, the spatial resolution of the RCM and the interdependency between RCMs are discussed. Taking this information into account a 2-year event is expected to increase by 20% over a projection period of 100 years. This approximates the variation within one natural oscillation cycle, indicating that it is crucial to understand and account for the future multi-decadal variations of extreme precipitation. The study estimates the expected magnitude of variation in design rainfall for urban drainage design due to anthropogenic climatic changes and natural variation. The analyses show that the most recent increase in design intensities is not attributed to anthropogenic climate change alone, but also heavily influenced by the natural variation of extreme rainfall. Together with a robust sign of increase in the design intensities, derived from an ensemble of climate models combined with different statistical downscaling methods, this gives confidence to the climate models? ability to project future change of extreme rainfall over Denmark. The potential interaction between the natural variability and changes driven by the anthropogenic forcing is still to be better understood. However, the generated knowledge can assist the design of robust adaptation measures for changes in pluvial flood risk.

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Mapping future flooding hazards from sea extremes and subsidence

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The management of flooding hazards in low- lying coastal areas calls for an integrated approach to the water loading from various sources. Furthermore, local subsidence in landfill areas and organic soils in many coastal towns must also be taken into account in order to evaluate current and future flooding hazards and management options. Water loading from all directions due to river discharge, precipitation, groundwater and the sea state (i.e. mean and extreme water levels) need to be carefully considered when dealing with flooding hazards at the coast. Flooding hazard and risk mapping are major topics in low-lying coastal areas before even considering the adverse effects of climate change and sea level rise (SLR). IPCC have yet again stated that mean sea level is rising and will continue to do so over the coming centuries, and that the rise very likely will contribute to an upward trend in extreme coastal high water levels. While permanent inundation due to SLR may be a prevalent issue, more often floods related to extreme events (storm surges) have the largest damage potential. Challenges are amplified in some areas, however, as a result of subsidence due to natural and/or anthropogenic causes. Subsidence rates of even a few mm/y may over time greatly impair the safety against flooding of coastal communities and must be accounted for in order to accomplish the economically most viable protection and management options now and in the future. Here, case studies are presented from Thyborøn and Aarhus (DK) to show how potential flooding extent and flooding depth during storm surges will increase in the future due to the combined effects of SLR and subsidence. By modelling the vertical land movement in a Digital Elevation Model (DEM), this gives a better spatial-temporal representation of the land surface and of the challenges ahead in relation both to flooding hazards and to groundwater and sewer systems? management issues. Based on the results from the two study sites, a practice-oriented methodology for detecting local subsidence areas and combining land movement and sea extremes in coastal flooding hazard mapping is being developed for Denmark. In addition to projections of SLR and re-evaluation of extreme statistics from tide gauge data series, this includes repeated high- precision levelling and various historical, geophysical and geotechnical data and modelling efforts. Here, the broad research focus is on developing methods based mainly on existing data and knowledge and on the synergies in bringing this knowledge together. This will generate results of great social value in relation to the climate change adaptation efforts across levels of government and the methods developed are believed to be of great commercial interest as a basis for the development of concrete solutions. The presented case studies show that it is both relevant and feasible to include local subsidence in flooding hazard mapping and climate change adaptation schemes. Geotechnical and geophysical data and knowledge to a large extent already exist and currently an effort is being made in order to bring this knowledge together to enable a practice- oriented methodology that combines the effects of local subsidence and future sea extremes in hazard mapping and climate change adaptation schemes in Denmark.

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A decision-making framework for flood risk management based on a Bayesian Influence Diagram

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We develop a Bayesian Influence Diagram (ID) approach for risk-based decision- making in flood management. . We show that it is a flexible decision-making tool to assess flood risk in a non-stationary environment and with an ability to test different adaptation measures in order to agree on the best combination of adaptation measures and the best time to invest in flood adaptation. IDs use Bayesian statistics which apply prior probabilities to produce posterior probabilities and, hence, use Bayesian probabilistic thinking to describe relationships between variables in a system. . Hence, we allow for assessing the risk of something we ?believe? may occur in the future. An ID has two layers; 1) a graphical description of the system built up by system variables, adaptation measures, costs/benefits of these measures and the dependencies of all these, which is an effective means to communicate the system configuration, and 2) conditional probability tables (CPTs) in which the domain of all possible states taken by the variable is listed combined with conditional probabilities of any state of that variable. When the ID is compiled, i.e. posterior probabilities are calculated; the network can be updated each time new values of variables are observed, assuring that the risk assessment is constantly based on best available knowledge for each variable. Input data to IDs can come from multiple sources, and since each variable is described with a probability density function (pdf) this method provides an effective means to describe uncertainty in the system. Hence, an ID contributes with several advantages in risk assessment and decision-making. We present an ID approach for risk- based decision-making in which we improve conventional flood risk assessments by including several types of hazards into the assessment. By doing so, we explicitly consider the risk from concurrent events. Further, we add large scale weather patterns to the risk assessment as an additional variable to describe the occurrence of extremes. This allows using projected changes in large scale circulations from climate models to estimate pdfs of extreme events in a future climate. Our method provides means to assess non- stationarity of flood risk by including several time steps in the risk assessment (? ström et al., 2013). Hence, our approach effectively communicates to decision-makers how risk changes over time and the uncertainty related to these changes. We combine a flexible impact assessment method with our ID that can assess the overall risk in a given area as well as within sub-areas. This impact assessment provides for a transparent and robust assessment of both instant and long-term benefits for different adaptation measures and combinations of these. Adaptation options can be tested at different points in time (in different time slices) which allows for finding the optimal time to invest. The usefulness of our decision-making framework was exemplified through case studies in Aarhus and Copenhagen. Risk-based decision-making is difficult, and considering the partly unknown processes related to anthropogenic climate change we need to model a very complex system. In our study we showed that IDs are a noteworthy alternative as decision-making method in flood risk management and is a useful method when several hazards and their simultaneous occurrence need to be assessed. The approach provided several benefits such as a transparent explanation of the system at risk, clear description of the uncertainty in the system and the changes over time, and flexible means to assess the best combination of adaptation measures.

Åström, H., Friis Hansen, P., Garré, L., & Arnbjerg-Nielsen, K. (2014). An influence diagram for urban flood risk assessment through pluvial flood hazards. submitted to Journal of Water and Climate.

Special session: Impacts of climate change on Nordic Primary Industries

Effects of climate on fish, fishery and economics - Experiences from the CLIFFIMA network

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The Nordforsk network ?Climate impact on fish, fishery industry and management in the Nordic Seas? (CLIFFIMA-net) has just ended. The network was an inter-disciplinary melting pot for natural, social and economic sciences and a forum between scientist and managers, and consisted of 40 participants from 13 institutions. The network ?Climate impact on fish, fishery industry and management in the Nordic Seas? (CLIFFIMA-net), funded by the Nordforsk Primary Industry Programme, brought together experts from the Nordic countries with strong engagement in fisheries and fish industry related to resources in the Nordic Seas. The network was an inter- disciplinary melting pot for natural, social and economic sciences and a forum between scientist and managers. The project ran from primo 2010- medio 2014 and includes 40 participants from 13 institutions. Fish stocks and climate have been well studied in the Nordic Seas, and much Nordic cooperation has been conducted over the years. However, the historically high expected temperature rise calls for developing new approaches. Effects of climate change on biological and societal systems represent added complexity to that already inherent in the physical climate systems. Due to this multifaceted complexity, there is a general need for interdisciplinary approaches. Climate change is driven by global processes, but works through regional physical climate systems, with profound potential effects on local scale. The network has tried to address these multi-scale properties through integration of knowledge on different scales. The geographical distribution of fisheries recourses in the high seas typically spans vast oceanic areas covering several national exclusive economic zones. The assessment and management of these resources are often shared among several countries. The Norwegian Sea and adjacent areas with associated fish stocks are a typical example of such an ocean area and the network have focused on the major commercial pelagic fish stocks in the Norwegian Sea. The network represents leading Nordic research institutions, and involves all the Nordic countries surrounding the Nordic Seas, and has established a foundation for developing Nordic research strategies within climate change impacts, adaptation and mitigation. The development of the joint spatial database, called NorMar (Nordic Marine data atlas), containing data on hydrography, fish, fisheries and potentially other ecosystem data, has been an important activity in the network as basis for a system for monitoring, collecting, storage, exchange, and reprocessing and accessibility of Nordic data. The system may become used for studies related to economical and other societal impact analyses. In this presentation the network, the database and the main results will be presented. .

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Challenges for Nordic livestock production and the role of farm animal genetic resources in climate change adaptation

Peer Berg, Anne Kettunen Præbel, Linn G; NordGen
Juha Kantanen; MTT Agrifood Research Finland
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Theo Meuwissen; Norwegian University of Life Sciences

Livestock production is the most important segment of north European agriculture and it both contributes to and is affected by climate change. Nevertheless, the role of farm animal genetic resources (AnGR) in the adaptation to and mitigation of climate change has not been thoroughly discussed in previous studies and reports. The Global Plan of Action for Animal Genetic Resources (FAO 2007) lists several associations between AnGR and adaptation to and mitigation of climate change, suggesting that sustainability and robustness of animal production systems and future food security require access to a wide diversity of AnGR. This is the focus of the Nordic Research Network on Animal Genetic Resources in the Adaptation to Climate Change (AnGR- NordicNET; https://sites.google.com/a/nordgen.org/angr/ home). In addition to adapting to changing climate livestock production has to increase productivity to feed an increasing human population. Climate change will challenge this ambition in several ways. Globally climate change is likely to result in increased variability in production and thus fluctuations in quantity, quality and prices of feeds for livestock production, particularly protein feeds that are to a large extent imported. Regionally extreme weather events are expected to become more frequent. Fertility, a fundamental trait for an efficient animal production, is a trait most likely to be affected by extreme weather events/climate change. Warmer and more humid weather, especially warmer winters are expected to result in new pathogens and/or vectors of pathogens to expand further north, as exemplified recently by Bluetongue disease. There are multiple options to address these challenges. It is argued that increasing self- sufficiency in the Nordic region should be a political objective. This would imply an expanding animal production for most Nordic countries and species. In particular, this has to be obtained by an increasing local production of protein for livestock feed, a combination of intensive agricultural production combined with an extensive but efficient use of marginal areas, e.g. for grazing, to utilise the production potential of the region. This stands in contrast to current trends. AnGR represented by species and breeds with different characteristics are essential to fulfil this ambition. Combining intensive high-input high-output production with extensive low-input high-quality output production requires access to and efficient use of AnGR; they are a prerequisite to develop breeds that are robust to a more variable environment with respect to both climate and emerging diseases. Adaptation to a changing climate needs to be fast and efficient in order to ensure an increasing production. This implies that current objectives of animal breeding should be re-evaluated relative to the changes required to adapt to changing production conditions, and that the most efficient genetic adaptation technologies should be applied. This includes adoption of genomic selection within breeds or genomic introgression for efficient introduction of specific desired characteristics from one breed to another. However, important knowledge gaps still exist to solve the challenge of adapting to a changing climate.

Fish in warmer waters: the case of the Arctic char

Sigurdur Gudjonsson; Institute of Freshwater Fisheries

To assess biodiversity responses to climate change in northern regions, a NordForsk funded research program, NordChar, was initiated. Arctic char (Salvelinus alpinus). The Arctic char was chosen as a model species due to wide distribution, with little anthropogenic effects. The char shows both phenotypic and genotypic responses to environmental change. The Arctic char is an ideal model species to investigate the effects of climate change on fish species as it is cold adapted, has a wide distribution, which is relatively little influenced by anthropogenic factors, and it displays great variation in phenotypic and life- history characteristics. In this study, both genetic and biological parameters were investigated to map the species variability. Biological and life history characteristics were extracted from the extensive literature. For the genetic mapping, mitochondrial DNA (mtDNA) was used as it interacts with the energy system of the cell. Genetic characters can therefore be expected to be sensitive to environmental temperature conditions in poikilotherms such as Arctic char. The genetic work involved two phases. In the first phase, we sequenced the whole mtDNA genome of 128 individuals, chosen to represent geographically and phylogenetically the biodiversity of the species. This robust overview of the genetic variation revealed that some parts of the mtDNA are very variable and in total 468 SNP?s was found. In the second phase, a detailed analysis was done of the phylogenetic and differentiation among populations within and among locations across the species range using 6 selected highly variable areas of the mtDNA. We sequenced these areas of 1600 individuals thereof where 60 for phylogenetic work locating different named char from the Salvelinus complex. The remaining 1540 samples were from approximately 80 different populations of arctic char from the whole distribution area of the species. At the same time this is an explorative genome scan to detect candidate loci for adaptation along then gradient of latitude or environmental temperature. Preliminary results show highly diverged lineages with regional distribution but moderately diverged lineages can be widely distributed geographically. Furthermore, moderately diverged lineages can be sympatric within the same watershed. The findings will be compared to different life history patterns. The study has produced a genetic tool that can be used to monitor adaptive genetic divergence in Arctic char. Furthermore, the findings will improve understanding on what happens as climate changes both for Arctic char and other fish species. Freshwater fish are often landlocked and can not move as climate changes. Fishes from anadromous population can find new habitats further north as water temperature increases. Arctic char is genetically variable fish and it has therefore potential to adapt to changed temperature condition as it has done through time. Changes will however occur including changes in growth, migratory phenology and life histories. It is likely that populations in the southern range of its distribution will become extinct as environmental conditions will exceed the tolerance of the species with climate warming. These issues call for special importance in fishery management.

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Nordic forest soil carbon storage and sinks - controlling factors and management

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The Forest Soil C-sink Nordic Network pa; FSC-sink

This presentation will summarize the results from a Nordic research network that has focused on forest soil carbon (C) storage. The spatial distribution of soil organic C was analyzed and effects of tree species, harvesting intensity, nitrogen deposition and land use change on soil organic C was investigated. Forests cover 60% of the land area in the five Nordic countries. These forests store massive amounts of carbon(C) and in forest ecosystems 50-80% of the C is stored below ground as soil organic C (SOC). The trees are sequestering CO2 from the atmosphere (which then in part is released by respiration and decomposition/burning of products) but the long-term storage of C is in the soil. It is important to protect and possibly enhance this storage of SOC. There is increasing knowledge and data on the amount of SOC in forest soils (particularly in the Nordic countries), but little is known about the rate of SOC accumulation in soils and which factor that affect the SOC storage. It is generally agreed that forest soils are current sinks for C (and thus contribute to mitigate the rise in atmospheric CO2 concentration), but the rate is uncertain. Also it is uncertain how much we can influence SOC storage through forest management. This presentation will summarize the results from a Nordic research network that has focused on forest soil C storage. With emphasis on the northern temperate and the boreal forest soils we have: ? Produced an overview of forest SOC stocks in the Nordic countries and explored which factors (climate, soil, species etc.) that influence the stocks ? Reviewed the influence of tree species on SOC stocks ? Reviewed the effect of increased tree-harvesting intensities on SOC stocks ? Tried to verify the hypothesis that elevated N deposition increase the SOC stocks though intensive observations in short stand scale N deposition gradients in forest edges ? Preformed a meta-analysis of changes in SOC stocks after afforestation (or natural succession). The SOC stocks decline from south to north in the Nordic region. We found C stocks to be higher under coniferous species than under broadleaf species though this difference was sometimes evened out if deeper mineral soils horizons were included. Information on harvest effects on SOC is still inconclusive. We found little support for a general positive effect of N deposition on SOC stocks, but found evidence that N deposition reduce the temperature sensitivity of soil organic matter making it less reactive to warming. After afforestation of arable soils there is a loss of SOC from the former plough- layer, but after 30-40 years the loss is replenished and the ?new? forest soil gain C compared to the arable soils. The presentation will conclude with a discussion of research needs for better projections of SOC stocks changes with climate and forest management and for suggesting mitigation options related to the forest soil C sink.

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Mitigating the risk of snow mould damage in high yielding grass species adapted for future climate.

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In the northern parts of Scandinavia plant production are carried out under combination of climate factors found on no other place on earth. A future climate, with increase in average temperature and longer growing seasons may represent both an opportunity and a challenge for crop production (Flæte et al 2010). High yielding grass-species, as perennial ryegrass and festulolium grown in this area would increase biomass production significantly. The main threat to this is winter damage since projected future climate indicate autumns with higher temperatures, more rain, and consequently less sunshine, a critical period for cold acclimation. A main challenge is snow mould attack because resistance to winter injury is highly dependent on cold acclimation of the plants in the autumn (Tronsmo 1984, 2013). Our approach for mitigating this risk is to identify genotypes that can contribute to new cultivars that are more resilient to changing climatic scenarios. That implies genes that confer resistance to snow mould independently of cold hardening. Promising material for further breeding of perennial ryegrass and festulolium were tested for snow mould resistance in controlled climate without cold acclimation, as well as in the field. A few of these candidates tolerated severe snow mould attack significantly better than the majority, and individual plants from these populations will be included in further breeding programmes. Among these few were a couple of cultivars adapted to Central European conditions, and therefore probably have higher production potential than cultivars adapted to current North European conditions. The traditional method for screening breeding material for variation in snow mould resistance is very time consuming. To find a faster and reliable method for identifying genotypes with high resistance, a method for estimating snow mould colonisation of individual plants based on quantitative real-time PCR was developed. Amount of fungal DNA in crown tissue of plants was significantly correlated with snow mould attack, but not until 3 weeks after inoculation. Another approach is aiming at identifying genes that contribute to snow mould resistance. Analyses of RNA expression in clonal plants of two genotypes of perennial ryegrass cv ?Fagerlin? have documented that snow mould already 4 days after inoculation, elicit expression of defence genes in susceptible and resistant genotypes differently, with a higher expression in plants of the resistant genotype. These results show that it is possible to identify genotypes of high yielding grasses that confer resistance to snow mould independently of cold hardening. However, genes conferring the ability to develop ?cold-induced? snow mould resistance will still be crucial for survival in years with ?old fashioned? winter. To breed the most resilient cultivars both types of resistance must be included. Substitution of traditional screening methods with determination of RNA expression a few days after inoculation may speed up selection for snow mould resistance significantly. But this approach will need further investigation, in particular on how environmental factor affect the RNA expression.

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Plenary - Mainstreaming

Towards a climate-proofed future

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Climate change poses new challenges and modifies existing ones for inter alia policy, physical and other planning, business decisions and regulations. As climate is already changing and as some amount of future change is unavoidable, it needs to be taken into account when considering activities which are sensitive to impacts of climate change. Some prominent examples are systems and practices which have sensitivities to extreme events, such as downpours, drought, heatwaves and storm surges. Impacts of successively unfolding changes in temperature (e.g. growing season, heating and cooling needs), sea level (e.g., infrastructure), and precipitation (e.g., water resources) are also relevant. Evolving mitigation efforts may also be relevant to consider in specific sectorial decision-making, such as changing price of energy due to climate policy development, land use for bioenergy, market demand for new solutions and consumption patterns. Finally, innovative societal and business development activities may directly contribute to adaptation and mitigation. For practical consideration of climate change, actionable information pertaining to the decision at hand is nevertheless needed. This may need to include knowledge on the system, process or suchlike itself, development of relevant markets and on relevant climate policy arenas.

Climate change is seldom the only factor that needs to be taken into account. Depending on the issue at hand, climate change may be a more or less important aspect compared to other factors, and it may either require immediate attention or will do so further down the line. A specific activity may also have bearing on multiple goals, with some of the influence being consistent with one another, and some being conflicting ones. There may be cases when climate change can be considered separately from other elements for a specific decision, such as for concerns on existing infrastructure or practices. In others, it is appropriate to consider it as a part of the bigger picture, such as in periodic revision of regulations or new purchases, investments and physical development. Such mainstreaming of climate change related measures promotes synergies, helps to avoid forms of maladaptation and to increase efficiency. This may contribute to demystifying climate change as such. It may also increase the acceptance of measures as it highlights that addressing climate change implies climate-proofing development trends, lifestyle, economic investments, environmental protection, security and so on, rather than no development or some other sacrifices.

Design Principles for Governance Arrangements for Climate Adaptation

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Adaptation to climate change is not only a technical issue but also a demanding matter of governance. Adaptation to climate change poses some specific, particularly demanding governance challenges like: important uncertainties; long term perspective; fragmented policy contexts; cross scale dynamics; and complex science-policy relations. Nowadays, governance is more than government. Governance is defined as the interactions between public and/or private entities ultimately aiming at the realization of collective goals. A governance arrangement is the ensemble of rules, processes and instruments that structure these interactions. This speech addresses what kind of governance arrangements can contribute to realizing adaptation options, and increasing the adaptive capacity of society.

Governance arrangements are operationalized in terms of policy frames, organisation of the decision making processes, responsibilities, steering instruments, normative principles, science-policy interfaces, scales and leadership. Effectiveness, legitimacy and resilience are the main criteria to evaluate these arrangements. The speech will present overarching insights of the Dutch governance of adaptation program (Knowledge for Climate; 2010-2014). The main research method was collaborative action research. This means that we took guidance from policymakers as the primary source of questions, dilemmas and empirical data, but also collaborate with them in testing insights and strategies, and evaluating their usefulness.

Most literature about climate adaption governance focusses on emphasizing the big long-term challenges of climate change, the many controversies, the need for participative approaches, the advantage of smart science-policy arrangement's, the importance of mainstreaming, etc. The insights resulting from the various research projects, however, show a more nuanced picture. Emphasizing the enormous challenges of climate change can also result in leaning backwards, participation is not always effective, emphasizing controversies can result in deadlocks, science-policy arrangements can also result in less innovative approaches, drawing clear boundaries between (for example) the public and the private is as important as boundary spanning, and cherry-picking can sometimes be more effective than integrating and mainstreaming everything.

What can journalism do? News Media Contributions to Citizens' Understanding of Climate Change

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Regarding climate change we often speak of the Global Commons. Seen in the light of Hannerz (1997) "global cultural commons", we can ask whether a critical global media commons – or moments of such a phenomenon – also occurs, linked for example to global negotiations on climate change? This paper presents some work from a global network – MediaClimate – on media coverage of the COPs. These summits represent good opportunities also to study interactions between and representations of a variety of actors engaged in Climate Change mitigation and adaptation. Furthermore it discusses the developments and dilemmas of the journalistic field in relation to the political field, both in a transnational and a global context. As Patrick Champagne iterates; the journalistic field "finds itself in a 'double bind' of sorts between politics and the market" (Champagne 2005) or a "commercial environment" (Boyce & Lewis 2009), while climate scientists seem to be sidelined in media coverage compared to politicians and NGOs (Eide & Kunelius 2012). In other words, views on climate change influenced by short-term concerns (elections every 4th year) are prone to overshadow academic science with its long-term perspectives.

But opinion research indicates that citizens, who obtain their information on climate change from media, are less skeptical towards IPCC than others, although media consumption is far from the only determinant. The same report indicates a substantial distrust in politicians' abilities to slow climate change (Austgulen & Stø 2013). This distrust may be strengthened by critical journalism, whose side effect may be less engagement among citizens. This occurs not least in a country such as Norway, a nation characterized by the paradox of being a major exporter of fossil fuel harbouring ambitions to play a leading role when it comes to climate change mitigation and adaptation. This discourse of the "tainted hero" (Eide & Ytterstad 2011) plays an important part of the Norwegian climate coverage, and can be seen as influencing a state of cognitive dissonance (Festinger 1957) among many. However, this dissonance may also motivate people to engage more.

Tuesday session 2 – IPCC AR5; so what now?

Adaptation to climate change in West-Africa - The experience of ACCIC, a regional project supported by DANIDA to support the adaptation in the region

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The drought that occurred in the West African Sahel during the early 1970s is considered to be unique not only by its severity, but also by its spatial extent. Some of the starking illustrations of this are the southward displacement of isohyetes by about 200 km over the whole region and the dramatic shrinking of the area occupied by free waters in Lake Chad. This resulted in massive socioeconomic and environmental disruptions in the region, whereby the local populations suffered severe food shortages and loss of assets, and the natural resources such as pastures and water bodies were largely depleted. This shock lead the decision makers of the region to put in place some institutional mechanisms that may help prevent or reduce the negative socioeconomic impacts of such events, if they were to occur in the future. The CILSS, French acronym for Permanent Interstates Committee for Drought Control in the Sahel was created in 1973 as a regional interstate body in such a context. CILSS has currently 13 member countries. AGRHYMET Regional Center, created in 1974 with the mission to train personnel, provide adequate equipment for the meteorological and hydrological stations networks and to monitor the meteorological, hydrological, crops and pastures conditions during the rainy season is one of the two technical centers of CILSS.

The extreme climatic phenomena continue to be a permanent threat, and the great spatio-temporal variability of rainfall remains a challenge. For example, the years 2009, 2011 and 2013 were characterized by very poor spatial and temporal distribution of rains, resulting in either late installation of crops, and thus the reduction of their production potential, or in their total failure in some regions due to the lack of rains during the most critical growth stages (flowering and maturation) of rainfed crops.

Throughout the years, AGRHYMET has developed, in collaboration with international research organizations, models and methodologies based on ground biophysical data collected by national meteorological, hydrological and agricultural agencies, complemented by the use of remotely sensed satellite data to monitor rainfall, food crop water requirements satisfaction and prospective yields, the progress of vegetation and its seasonal and inter-annual variations. These elements constitute an information system that allows issuing early warnings and management of natural resources. A number of regional projects focused on the adaptation of climate variability and change have been implemented in the region.

Despite these achievements in the region, the region continues to face a number of challenges: maintaining good quality data collection, high uncertainty in climate scenarios in the region, weak capacity in seasonal and intra-seasonal forecasting. It was in context, that AGRHYMET Regional center in collaboration with the Danish Meteorological Institute (DMI) and Institute for Geography and Geology, University of Copenhagen (IGG) have requested a financial support from the Danish Development Agency (DANIDA) to implement the ACCIC (Appui à l'adaptation au changement climatique en Afrique de l'Ouest par l'amélioration de l'information climatique) project. The project vision is to establish a regional platform in support of development and implementation of climate adaptation strategies in West Africa; to be obtained by building up regional and national knowledge based on scientific, technical and information cooperation between Danish and West African experts within agro- and hydro-meteorology in combination with regional climate change and regional to local adaptation expertise. The different focuses of the project are:

- Protection, consolidation and enhancement of existing meteorological and hydrological observation networks and historical climate data.
- Improved data handling and analysis techniques, including establishment of easier access to quality assured data
- Processing of databases for satellite-based regional climate information
- Improved weather and climate related forecasts and warnings to agriculture and water sector
- Improved regional climate predictions (seasonal) and scenarios (50-100 years ahead) with associated impacts on agriculture, natural resources and the water sector for the future (near term, mid-century and end of century).
- Improved communication to the end-users.

Learning from extreme weather events in German utilities: how sensemaking influences private adaptation

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Our empirical analysis of two German utilities (Energy, Railway) shows that they both do not see a need for adaptation. Although they already experienced disruptions due to extreme weather events they perceive climate change as a distant and manageable problem. They rely on standardization and assume that standardization bodies will become active if necessary. Climate change causes direct and indirect risks for businesses and results in a need for private adaptation. A precondition for dealing with climate change is that companies recognize and make sense of climate change related risks. Based on a conceptual background in sensemaking (Weick 2001; Weick et al. 1995; Maitlis & Christianson 2014) and learning from rare events (March et al. 1991; Starbuck 2009) we conducted case studies in two German utilities (Energy and Railway). The case studies comprise document analysis, interviews and group discussions with company members from different units. We find that both utilities have already suffered from extreme weather events. However, they do not yet perceive these as a sign of broader climate change. Both utilities are currently convinced that they are well prepared to deal with climate change impacts and they perceive climate change as a manageable risk that can mainly be treated by technical measures. They rely on established behavior and ignore that climate change may lead to discontinuities and massive change, which cannot be dealt with by current strategies. This perception is enforced by a strong dependency and reliance on standardization and a regulatory environment that rather supports efficiency than reliability. The utilities show typical patterns that constrain learning from rare events such as cautious action, wishful thinking or searching for more data (see Starbuck 2009). Moreover, the utilities shift responsibilities to other actors (standardization organizations, regulating authorities) and use missing action from others as a reason for their own inaction. In stressing the responsibility of others, the utilities treat climate change impacts as an external problem that cannot be influenced by internal action. Our findings illustrate how and why companies fail to develop a sufficient threshold of concern about climate change. We conclude that external triggers (e.g. changes in standards or regulation) and external support (e.g. provision of tailored information such as risk maps) may help to create a willingness to act on climate risks. Likewise, we assume changes in standards to be a suitable approach in supporting private adaptation. We moreover conclude that organizational slack is important in developing a sufficient willingness to act, in increasing robustness, and in implementing adaptation measures.

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The Green Climate Fund: UN Climate Change Conference Delegates? Perspectives on Capitalization and Balanced Allocation Between Adaptation and Mitigation

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While long-term finance is pledged (USD100 billion annually from 2020 onwards), its linkages to the Green Climate Fund remains unclear. The extent of channelling LTF through the GCF determine how much funding will be prioritized towards adaptation or mitigation. This article explores the preferences of UN delegates on these issues. Finance is the heart of UN climate diplomacy. Developed countries have pledged US$100 billion annually from 2020 and onwards. Concurrently, the Green Climate Fund, GCF, has been established. Through a survey at the UN Climate Change Conference in Warsaw 2013, this policy analysis presents how delegates envisage 1) the share of long-term finance that should be governed by the GCF, 2) the mitigation/adaptation ratio in the GCF?s support, and 3) the public/private ratio in the GCF?s financial sources. The sharpest dividing line is on the the governance of long-term finance: developing country delegates prefer channeling long-term finance through the GCF much more than do developed country delegates. Since long term finance is pledged in a context of mitigation whereas the GCF should balance allocation between adaptation and mitigation, the issue of to what extent long-term finance should be governed by the GCF is highly contentious. Developing country delegates further prefer the GCF to allocate a slightly higher share of the funds to adaptation, elevating the contestation. A COP decision can be facilitated by providing more clarity on contextual issues through decision by the more procedurally efficient GCF Board. The GCF Board should: 1) specify what is meant by ?balanced? when it comes to allocating funds between its two funding windows for adaptation and mitigation, and 2) estimate how and by what multitude the grants given to the fund, which is most likely to come exclusively from public sources, are likely to be leveraged by incentivizing private investments. If clarity is sought, it is important that the latter is specified for both adaptation and mitigation actions, since the ratio is likely to be different for the different funding windows.

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Some advanced in adapting water resources management to climate change in Quebec (Canada)

Turcotte, Richard; Ouranos and CEHQ
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Cyr, Jean-Francois; Ouranos and CEHQ
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Climate change will impact the use of water in Quebec currently relatively unconstraint. Examples in the field of water withdrawal, floodplain and dam management will be discussed in the context of integrated watershed management. A status on global hydrological impacts assessments and related communication tools will also be given. The historical development of the province of Quebec in Canada is related to the abundance of water. Abundance is also the reason why floods are biggest natural risks especially when snowmelt occurs. However, an increase in problems related to low flows is observed since the 2000s. Like elsewhere in the world, the water management in Quebec is done by a large number of actors and is controlled by numerous legislative rules. In the recent years, frameworks for integrated water management for both Quebec watersheds and St. Lawrence River were implemented. They may be helpful for adaptation to climate change. Aiming to do research that support adaptation, the Ouranos consortium is a boundary organisation that contributes, between others, to the realization of the Quebec's Climate change action plan. Created in 2001, Ouranos network brings together nowadays more than 450 specialists in climate science and specialists and decision makers in different disciplines such as water resources management. In the latter, research activities are mainly oriented for 1) producing useful information about bio-physical impacts for a large number of end- users; and 2) developing tools and expertises, including technical and socio-economical aspects, that support adaptation initiatives at watershed scale in a perspective of integrated management. The objective of the presentation is to discuss main realizations, lessons learned and future developments in the field of water resources. For bio-physical impacts, large organizations active in hydrology in Quebec have pooled together their efforts to assess in a coherent way changes on river flows for the entire province (1500000km2). Widely disseminated products like the Hydroclimatic atlas of southern Quebec and his associated communication tools will also be presented. Assessment of other parameters (Groundwater, Water quality, ...) will be at the foreground of research in the coming years. For adaptation, studies inspired by current water issues for which the amplification of problems by climate change motivates end-users to take adaptation actions were conducted. Technical and/or socio-economical analysis of adaptation options were realized in the field of water withdrawal management, floodplain management and dam management. Some other examples would be discussed: 1) the implementation of a flood forecasting system as significant adaptation step taken in 2013; 2) the periodical nature of safety assessments imposed by the dam safety Act as driving factor for adaptation; and 3) the introduction of climate change in future water master plans of Quebec watershed organisations. Despite the progress realized since 2001, the implementation of adaptation measures identified by studies in water resources done in Quebec remains rare. The co- construction and the co-realization of future projects by end-users, water specialists and scientists may be the solution for helping the implementation of more adaptation measures. Given the abundance, the use of water resources in Quebec were relatively unconstraint when compared to other parts of the world. It is very likely that adaptation to climate change will implies a tighter management of the resource. In this changing context, socio- economical analysis, in addition to technical ones, will be crucial.

none

Climate change adaptation in the transport sector: The Nordic Experience

Marko Nokkala; VTT Research Centre of Finland
Riitta Molarius; VTT Research Centre of Finland
Tony Rosqvist; VTT Research Centre of Finland

This paper, by the coordinators of two current EU FP7 projects, synthesises findings so far from these, and three past EU projects, focusing on transport sector adaptation. Specific focus of this paper is the Nordic countries, experiencing a change in winter conditions, resulting in new management and operations challenges. From MOWE-IT project this paper focuses on long-term policy recommendations generated through reviews of best practices by transport modes and also looking at the cross- modality between transport modes in cases of disruptions. For each transport mode the particular climate change related challenges were identified, including thresholds of weather events that trigger problems to resilience. Given projections up to 2040 and 2070 it has been possible to see what expected trends in frequency of disruptions are and what their geographical distribution in Europe is. According to TodDAd interviews it seems that Nordic transport sector does not have any specific strategies to adapt to climate change, but it has been strongly under discussions. Because new roads and railways are planned and built according to high quality standards, slowly changing climate is not a threat. Extreme weather events can damage infrastructure, and the construction standards used must be one step ahead. As a specific challenge in Northern the frequency of mild winters will increase and leads to challenging in regular winter maintenance. MOWE-IT project has provided guidance on how policies need to adapt to such changes.

www.mowe-it.eu www.topdad.eu ewent.vtt.fi

Tuesday session 2 - Mainstreaming

Waters with(out) Borders ? The Matter of Decentralisation on Climate Change Adaptation in North Denmark

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Waters run across administrative borders and efforts in one municipality may course flooding in a neighbouring municipality if not coordinated. This research investigates the implications in coordinating climate change adaptation after two decentralising structural reforms and what this means for the necessary horizontal collaboration between local authorities and utility companies. Climate change adaptation is a new policy field and can be found in an institutional void where practices are still to be defined, leaving a new and interesting field for both research and practice. The context of this paper is Denmark and the enforcement of a new legal requirement of municipal climate change adaptation action plans. It was enacted in December 2012 and put into effect in 2013 with demand of finalised action plans, including risk assessment and prioritisation of actions, by the end of 2013. In addition to this policy field being new, two recent structural reforms, the municipal structural reform put into effect in 2007 and the privatisation of utilities put into effect in 2009, further complicate it. Based on a conceptual framework dealing with centralisation and decentralisation (e.g. Rouse 2007), governing and governance (e.g. Kooiman 2003), and structure and agency (e.g. Cashmore and Wejs 2014), this article discusses the implications for coordinating climate change adaptation across administrative borders. The geographical area of this study is North Denmark, with the Limfjord cutting across the Jutland peninsular from the North Sea to Kattegat. The municipalities within this region border the Limfjord, several streams and/or the coast, and flooding incidents from these sources are increasing due to more heavy rains and storm surges. To investigate the current coordinating efforts to adapt to flooding, 10 semi-structured interviews have been carried out in the period from 11th March to 14th April 2013. The interviews have been conducted with relevant professionals from six local authorities, the North Denmark Region and three sewer utility companies. This article finds that the recent decentralising structural municipal reform and the privatisation of wastewater utilities hamper a coordinated climate change adaptation effort within North Denmark. The municipal structural reform demolished counties and left the main environmental and spatial responsibilities with the municipalities, and the privatisation of utility companies emphasises service and revenue over climate adaptation. The larger degree of decentralisation means that implicated actors act within a fragmented policy area, where network governance becomes essential. However, networks are first to be established and the lack of agency results in inaction, whereas the decentralisation seems to hinder climate change adaptation and calls for more regulation to secure action. This research contributes to explanations of the current lack of implementation of climate adaptation action plans. Supplementary, it provides insights for practitioners in the importance of establishing networks for coordinating efforts when acting in fragmented and decentralised policy fields.

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Using and visualising climate projections for adaptation planning in local government in the UK – a user study of adaptation

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This paper explores the current use and communication of climate projections at Local Authority level in England, highlighting not only the range of and change in demand for communication towards relevant officers in the Local Authorities but also how they further communicate this information along the decision-making and policy-planning chain.

Past research has shown that performance indicators have contributed substantially to putting climate change adaptation on the local government agenda (Keskitalo et al. 2012) and has highlighted the potential negative impact of abolishing the indicator framework (Cooper & Pearce 2011). More than that though, are they also drivers for the use of climate projections in the adaptation process? The UK has showcased a significant statutory reporting framework at Local Government level around adaptation, in the form of the process based national performance indicator 188 'Planning to adapt to climate change' (NI188), in place from 2008 – 2011. During this period there was also an increased awareness for the use of climate projections in adaptation planning, linked to the release of the UK Climate Projections in 2009.

This paper is based on the results from a survey conducted with 99 Local Authorities across the UK and 25 semi-structured interviews with municipal climate adaptation practitioners focusing mainly on the East Midlands and South East region. The aim of the survey was to see not only how the respondents understand different visual styles of presenting climate change projections that portray the same information content but also their preferences for using these in the planning and communication process for adaptation in their organisations.

The results highlight that the abolishment of the national indicator reporting framework has in many instances led to a reduction of actions on adaptation due to competing economic pressures. As adaptation in many Local Authorities is being pushed onto a backburner, detailed climate projections seem too far removed from current social, political and economic realities at this scale leading to a reduction in demand for them. Nevertheless, there is still a clear demand for better communication of climate information. However, the survey results show that meeting this demand needs to be undertaken with the understanding that even within a fairly homogenous user group, i.e. climate adaptation practitioners in local government, we can see distinct differences in respondents' accuracy and preference for the different climate projection graph formats displayed. In addition, we find that respondents' objective understanding of a graph format (measured by means of an accuracy score) and their subjective understanding of how easy a graph format is to understand or how useful it is in the planning process, do not always match.

The main findings of this paper are twofold. Firstly, we provide the empirical evidence for the negative impact of the abolition of the statutory reporting framework not only on adaptation at local level in the UK, but also on the use of climate projections to inform adaptation planning. Secondly, the various 'within-group' differences in ability and preference regarding the communication of the projections highlight that even targeted communication of projections to Local Government adaptation practitioners will be interpreted and understood differently by the individual practitioners.

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Farmers as water managers - extreme runoff and adaptation options in rural areas

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For rare extreme runoff events and flooding risks of downstream towns from upstream rural areas, there are no easy identifiable win-win solutions which form a strong business case for public-farmer partnerships as part of climate change adaptation. Land use adaptations are not enough to balance climate generated increases in runoff. As part of the GUDP project ?The farmer as a water manager? a workshop was arranged in Horsens, Denmark in March 2014 with 30 invited stakeholders including representatives from agriculture, local authorities, water company, nature conservationists and researchers. The purpose was to discuss adaptation measures for holding back water in the catchment and reducing the risks of river flooding in downstream Horsens town from upstream Bygholm-Hansted river catchment. The aim was to identify a strong business case for public-farmer partnerships based on win-win solutions. A catalogue of a half dozen adaptation measures had been compiled and was presented to the stakeholders. Efficiency of selected measures was evaluated by peakflow factor (the obtained max flow with adaptation measures implemented divided by the present land use-river system). Sensitivity analysis showed, that if the total arable land was converted into forest (conifers) a peak flow factor of 0,8 was obtained. Holding back water in drains and changing the root zone capacity by increased humus content, would result in a peak flow factors around 0,95. Other measures like moderating surface roughness, establishing wetlands in the river valley, changing to other crops etc. practically had no impact during rare river runoff events (T=50-100 years or above). For the summer period they might have a higher peak flow factor impact (1/5-1/10) and delay the high flows in the late autumn period, but since all annual max flow occur during winter, they could not reduce flooding risks significantly. A national modeling (Henriksen et al. 2013/2014) had resulted in climate factors (max runoff for future period divided by same max runoff for reference period) between 1,2 and 1,5 for yearly max runoff and 1,5 ? 2,0 for summer period (1/5-1/10) for a 100 year event (T=100 year) based on downscaled ENSEMBLEs climate model inputs from 9 models to the national water resource model, and extreme value analysis (EVA - MIKE SHE/MIKE 11). Hence, in order to balance the increased flooding risk from rivers (climate factor of 1,2-1,5) an adaption efficiency expressed as peakflow factor of 0,65- 0,8 is required for yearly max runoff (and 0,5 ? 0,65 for summer period 1/5-1/10) for a rare events. For very rare events the extreme value analysis (Peaks over threshold- /Generalised Pareto) was largest source of uncertainty. For more frequent events, variability and climate model inputs from the 9 different ENSEMBLES models is the mainuncertainty. Downscaling was based on DBS(Seaby et al., 2013). ?The farmer as water manager? workshop in Horsens did not identify easy win-win adaptation options for reducing flooding risks caused by extreme runoff from the catchment. Of the identified half dozen adaptation measures relevant for public-farmer partnerships (land owners/farmers) for protecting downstream towns like Horsens, none were identified as easy win-win solutions, and many had adverse negative impacts on environment, biodiversity etc. They might delay the peak flow (days or hours). For such rare events either to live with the flooding or construct large scale flood defence structures is required, changing land use, drainage or wetlands will not help much.

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Flood compensation in the Nordic countries - changing flood regimes and compensation systems

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An expected impact of climate change is a changed flood regime, with floods occurring at new places and at different times of the year than previously experienced. Furthermore, higher frequency of intense precipitation could lead to flash floods. These new trends are already being observed many places, and flood damage to private and public properties could increase and result in higher compensation claims. In this context, climate change adaptation thus relies on compensation and insurance schemes that allow actors to restore private and public properties damaged by natural hazards. The compensation schemes for flood damage in the Nordic countries are in the process of being changed in the ways in which they are organised. The Finnish system has changed from a public compensation to a private insurance system with large social repercussions. In Norway, expected climate change impacts have led to discussions on how the compensation scheme is to change to cater for increased damage from natural hazards, and a change to the law is in progress. Cases from each of these countries will be presented and discussed. In the Norwegian system, flood damages lead to the largest compensations. Damage to farmland from summer flooding in 2012 in Northern Norway reveals that the current systems struggle to deal with compensation for damage from large and unexpected floods, as well as increased claims overall. Almost two years after the flood, some of the damages are yet to be formally evaluated, and several farmers were waiting for compensation. Interviews with affected farmers revealed that an agreement that the compensation scheme is good, but that it becomes problematic to pay repairing costs upfront in order to be able to continue farming, while waiting for the compensation pay-out. The background documents to the proposed new law argue in favour of keeping the state compensation system for private property in Norway. This is different to the changes made to the Finnish system, which has now been changed to a private system. This change in definition of risk responsibility has potentially large repercussions for private actors. In this paper we will discuss the overarching developments of flood damage insurance and compensation in Finland and Norway. Further, we will discuss how a changing climate and a changed compensation scheme have implications for individuals in the three countries. We particularly discuss the question of responsibility and distribution of risk to natural hazards.

VisAdapt: development and evaluation of an adaptation decision-making tool for homeowners

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VisAdapt is a web-based visualization supported tool, designed to increase Nordic homeowner's understanding of climate change vulnerability and to support their adaptation actions. The project is part of the Nordic Centre of Excellence NORD-STAR and involves collaboration with four Nordic Insurance Companies. The VisAdapt tool (Neset et al 2013) integrates geographic visualization, visual analytics and information visualization techniques to support homeowners in assessing and responding to expected climate change impacts. VisAdapt is structured to enable the individual user to explore a number of climate change impact parameters, e.g. changes in temperature and precipitation including heavy rainfall and heat waves, which are relevant for their location, and to find information on specific adaptation measures for their house type (Glaas 2014). To achieve an efficient analysis of this multidimensional data, VisAdapt incorporates multiple visualization techniques as well as coordinated and linked views to enable the user to identify interesting patterns for the selected regions. Techniques for representations of uncertainty, which are a key aspect of climate visualization, are developed and tested in experimental and participatory settings with user groups. Furthermore, an assessment of 20 map-based visualization tools for climate adaptation has been conducted to guide the development process (Neset et al fc). VisAdapt is structured in three distinct sections, comprising 1) the house builder, where the user, after entering a specific address, is enabled to select features of the house, such as roof material, building structure, garden terrain etc. 2) a section on climate scenario data presenting relevant climate parameters (e.g. temperature, heavy precipitation), exposure indices for e.g. flooding and storm, and specific risk mappings for e.g. sea level rise and food-risk zones. 3) a guide for adaptation measures, structured under various climate impacts (e.g. temperature, cloudburst) and sorted according to relevance depending on the selected house type and climatic parameters for the selected location. During the development process of the VisAdapt tool several evaluation sessions were conducted with home owners and professional users from the public and insurance sector to address key research challenges such as the assessment, representation and communication of climate change impacts and natural hazards and their inherent uncertainties, as well as communication of climate change adaptation measures to different audiences. This study presents an assessment of specific criteria for designing map-based visualization tools for climate adaptation, comprising the selection of adequate data content, level of interactivity and functionality for different user groups. Results from evaluations with representatives of the insurance sector, home owners and sector professionals working with climate adaptation issues on local, regional or national level show a broad scope of demands posed to this type of tools, and open up for a discussion on future development. The project is part of the Nordic Centre of Excellence NORD-STAR and collaboration with four Nordic Insurance Companies.

Glaas, E. 2014. A mapping of climate change risks and adaptation guidelines to homeowners in Denmark, Norway and Sweden. Center for Climate Science and Policy Research, Briefing No. 11, 2014. Linköping University, Norrköping, Sweden Neset, T-S., Linnér, B-O., Glaas, E., Navarra, C., Johansson, J., Opach, T., Rød, J., Gammelgaard Ballantyne, A. and Goodsite, M. (2013). In Hac Vita Project Briefing No 1, 2013. Centre for Climate Science and Policy Research, Linköping University, Norrköping, Sweden. Available at www.cspr.se
Neset, T-S., Opach, T, Lilja, A., Lion, P., Johansson, J. (fc). Map-Based Web Tools for Climate Change Adaptation. (submitted manuscript)

Tuesday session 2 – Limits and opportunities

Towards a climate secured Scania

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Aiming to develop an integrated scientific basis for public decisions that can lead to a sustainable and climate adapted local to regional society, Lund University together with local and regional authorities are examining Scanias position in relation to the national and international climate and energy policy framework and recommendations with respect to ecological, technical and societal challenges and opportunities. During the present century, the global society and ecosystems will experience multiple and rapidly increasing effects of climate change (IPCC 2013, 2014). To support the society in the efforts to make informed decisions aiming towards a sustainable future under climate and societal change, stakeholder interactions and interdisciplinary research cooperation is a way for the scientific community to deliver information needed to assess the risks humanity is facing from global change. Aiming to develop an integrated scientific basis for decision-making that can lead to a sustainable and climate adapted Scania (southern Sweden), Lund University together with the Regional Council, the County Administrative Board and the Association of Local Authorities are examining Scanias position in relation to the national and international climate and energy policy framework, policy decisions and recommendations. This means a scientifically based analysis of the regions already taken and ongoing strategies and decisions, and the identification of possible synergies and trade-offs between ecological, technical and societal challenges and opportunities. Climate challenges and opportunities related to agriculture, forestry, tourism and recreation, environmental protection, energy supply and transport, urban and landscape planning, and human health effects are assessed for a time horizon of 10, 30 and 80 years. The project examines how climate change is expected to affect the future development of Scania via direct effects on the natural environment through biodiversity, the returns from the woods and fields, and other ecosystem services, as well as on energy, transport, infrastructure and urban planning. Indirect effects assessed include increased competition over land areas for food, energy and infrastructure purposes, and effects of national and international policies changing the playing field for market participants as well as for local and regional decision makers and the public. A special focus is placed on climate direct and indirect effects on society actors: challenges and opportunities for business within the projects main areas, of democratic processes and tools for policy makers and market forces to stimulate sustainability, and on the individuals capacity to influence events and their situation in the context of social norms and existing technology systems. Although the climate development during this century and onwards is depending on decisions and cooperation on international and national levels, sustainable development and climate adaptation has a clear local to regional dimension. Local and regional actors have of course a strong vested interest in the systems they depend on. Further, actions to ensure a sustainable use of resources on this scale, as well as urban planning and climate adaptation, are made both using institutional measures which lay the foundation for a variety of decision-making and sector areas, and through specific actions on the project level. Management of the local/regional assets and resources involves academia, decision makers, the public and the business community alike.

IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Towards Water Sensitive Cities of Sweden, The Necessity for re-thinking the way we plan our cities

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Future global challenges have forced us to think more about our living environment. Many countries have already started to transform their cities, making them more resilient against expected challenges and unpredictable difficulties. Those countries are actively looking for better solutions and policies. Besides climate changes and rapid urbanization, precipitation in northern Europe is expected to increase by 20% until the year 2100. This paper is emphasizing the importance for Sweden, as a country with water abundance, to make its cities more resilient through water sensitivity. The world population is growing four times faster than the rural population. By 2025 almost two thirds of the world population will be living in cities. Thus, it is important for the cities of the future to be designed according to the needs of its citizens. Due to the vital role of water in our cities as well as dealing with all its related problems, from water scarcity to extreme floods, water security is of critical importance. It needs to be addressed in the process of our cities planning. Water security is a fundamental need for urban areas and its achievement will be counted as a huge success for all cities around the world. Many countries such as Australia, Netherlands, UK, USA, etc. are now focusing on applying new strategies to their critical cities and helping them to live in harmony with natural water environments. Usually the related measures start after catastrophes that cause water crisis. It begins with following a new paradigm, in the planning and design of urban environments, which is ?sensitive? to the issues of water sustainability and environmental protection. After damages from the Copenhagen flood in 2011, even Denmark feels the urgency of adapting its cities to unexpected water challenges. This paper is focusing on understanding the impact of water planning on the master plans of the Swedish cities and vice verse. Having the city of Malmö as its third largest city located within 40 kilometers from Copenhagen, Sweden will be one of the countries that need to protect itself during further urban development. Sweden aims to become one of the most sustainable countries in the world, which includes both sustainable water services and urbanism. Thus it is necessary to revise the process of designing the cities and make them more resilient to the water challenges in future. The paper starts with calculating the BCI (Blue City Index) of some cities and follows with evaluating their future needs. Also new planning hierarchy will be proposed to reveal how sustainable water services can be implemented in the long term. The expected outcome will show how the gap between physical and technical planning of Swedish cities could be reduced. While solving different types of urban water problems is not about taking one-sided decisions, it also requires a bottom-up approach and collaboration among all water sectors. The obtained results of this project could be used as a tool to improve the cooperation for engineers and city planners, during the process of urban/water planning. Furthermore, through promoting better water arrangements and transparency it provides the Swedish municipalities with a more systematic way of dealing with future water problems.

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[2] Backhaus A. (2011) Urban Stormwater Landscapes ? Values and Design. PhD Thesis, University of Copenhagen, Department of Danish Centre for Forest, Landscape and Planning.

[3] Dolman N., Savage A. and Ogunyoye F. (2012) Water-sensitive urban design - Learning from the experience. ICE Publishing. [4] Fryd O., Backhaus A., Birch H., Fratini C. F., Ingvertsen S. T., Jeppesen J., Panduro T. E., Roldin

M. and Jensen M. B. (2013) Water sensitive urban design retrofits in Copenhagen - 40% to the sewer 60% to the city. IWA Publishing.

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6] Mottaghi M. (2012) From Garden City to Green City ? New ecological life, Esfahan-Iran. Master?s Thesis, Lund University, LTH Department of Architecture and Built Environment.

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[10] Wong T.H.F., Allen R., Beringer J., Brown R.R., Chaudhri V., Deletid A., Fletcher T.D., Gernjak W., Hodyl L., Jakob C., Reeder M., Tapper N. and Walsh C. (2011) blueprint2011 Stormwater Management in a Water Sensitive City. The Centre for Water Sensitive Cities, Monash University.

Sharing adaptation knowledge and experiences to overcome barriers and seize opportunities? workshops as a successful learning-tool to progress in adaptation

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Learning from each other was found to be one of the most important outcomes participants (15%) took home after attending workshops hosted or co- hosted by CIRCLE-2. About a third of workshop participants stated that attending the workshop contributed to developing ideas on measures or strategies for climate change adaptation. What should we do within adaptation? How should we do it? These are two key questions for many decision- makers. One important way to deal with these questions is to share knowledge with others facing similar challenges. The concept of dialogue may be one way to deal with the communication. Adaptation in itself has been described as a social learning process (Klein, R. et all, 2014). These were part of the central idea when the work-package SHARE was designed in the proposal of Climate Impact Research and response Coordination for a Larger Europe (CIRCLE-2) an ERA-Net and FP-7 project (from 2010 to 2014). During four years the CIRCLE-2 consortium (co-)organized more than 20 workshops and conferences in the area of climate change impacts, vulnerability and adaptation, with a focus on knowledge sharing and exchange, starting up a dialogue between policy-makers, decision- makers, scientists and practitioners. Attention was given to how the communication between these players can be facilitated ? within a room (Groot, Hollaender, Swart, 2014) and across national borders, even reaching to the developing countries (Swart et al, 2014). Here we describe how the sharing of adaptation knowledge and experiences to overcome barriers and seize opportunities between countries, and levels, in a range of workshops and events, had an impact on the work on policies and decisions in other countries in Europe and beyond. Our conclusions are based on experiences from the events organized, mainly from a survey among workshop participants covering 21 workshops and conferences. The survey was sent out to more than 500 participants in late March 2014, and 70 people answered within the timeframe. The analysis include these answers, together with other associated work within CIRCLE-2, such as the Inspiration Book (Pijnappels, M and Dielt, P, 2013) with examples of implemented adaptation measures and the initiative on how to deal with uncertainties (Lourenço, T. et al, 2014), with examples from different projects. Respondents noted up to three important uses from the workshop/s, and then commented on the impact of the workshop/s have had on her/his organization. Around one third (29 %) stated that attending the workshop contributed to developing ideas on measures or strategies for climate change adaptation within their organization, and more than half of the survey participants (54%) stated that attending the workshops stimulated new ways of preparing and or conducting research within climate change impacts, vulnerability and adaptation. The CIRCLE-2 workshop series was intended to kick start productive interactions between science, practice and policy. The overall results of a survey among workshop participants show that the strategy to develop parts of CIRCLE-2, namely work package SHARE, as a vehicle driving such interactions, via mutual learning and knowledge exchange was successful. Thus, for future projects, we recommend to have a strong emphasis on SHARE elements: organizing knowledge exchanges, networking and creating a real open space for mutual learning between science, practice and policy.

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- Klein, R et al.(2014) IPCC-WGII-AR5: Chapter 16
- Lourenço, T et al.(2014) Adapting to an Uncertain Climate: Lessons From Practice, Springer
- Pijnappels, M. and Dielt, P.(2013) CIRCLE-2 Adaptation Inspiration Book, http://www.circle-era.eu/np4/InspireBook.html
- Swart, R et al.(2014).Learning through collaboration? CIRCLE-2_research_policy_brief.

Political climate adaptation decisions in Germany from an economic point of view - shortfalls and possible applications for decision support systems

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Before the European-Adaptation-Strategy has been brought forward by the European Commission in 2013 to support action in the member-states, several political processes in that regard had already been started in Germany. Adaptation-strategies on national and regional level were aimed to shape the future adaptation actions of public and private actors. First, this paper constructs a framework to evaluate political adaptation strategies from an economic point of view. Four basic climate adaptation policy fields are identified: regulatory framework setting, elimination of market failures, distributive justice and security of supply. While the adaptation of the regulatory framework (e.g. property rights, land use rights, institutional responsibilities) has been initiated by the German adaptation strategy, distributive justice and security of supply are neglected. The elimination of market failures is not explicitly mentioned, but it is partially covered by the planned actions. In general the German adaption strategy is neither consequently derived from economic considerations nor structured accordingly. Besides direct regulation and market based instruments (e.g. taxes), public provision of adaptation measures (e.g. dyke-building) is a major instrument of climate adaptation policy. At the same time it is prone to several difficulties. Because resources are limited, the available measures must be prioritised on the basis of relevant criteria. Aside from cost-benefit considerations, other less tangible criteria (e.g. fairness and robustness) have to be taken into account as well. Other difficulties include the proneness of public adaptation decisions to political barriers (e.g. rent-seeking) and the uncertainty connected with the relevant information (e.g. climate scenarios). The overall aim of public adaptation should be an efficient provision of economically justified adaptation. The German adaptation strategy however lacks a structured approach to prioritise the available adaptation options adequately. Second, based on the identified shortcomings, respective requirements and applications are developed for decision support methods (e.g. cost-benefit analysis, multi criteria analysis, robust decision making). Appropriate methods are required to incorporate cost-benefit information, assessments on fairness and robustness. Decision support methods should be capable of prioritising public adaptation according to these criteria and rationalise political decisions by means of disclosure and monitoring. Moreover, from a procedural perspective, the decision making process should be designed for acceptance and fairness (e.g. stakeholder engagement). Finally, the requirements from the user?s perspective include completeness, flexibility, comprehensibility and applicability under uncertainty. The results are relevant for governments which plan to develop their adaptation strategies further by use of decision support methods.

Risk Assessment and Regional Action Plans - Guidance for Climate Change Adaption in Sweden

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The 21 County Administrative Boards (CABs) of Sweden task is to formulate Regional Adaptation Action Plans (RAP) for Climate Change Adaptation in cooperation with relevant actors, with the purpose to provide guidance for municipalities and other regional actors. The CABs have the autonomy to plan the work with RAP according to their respective regional conditions. The regional network of CABs in southern Sweden will present how the work has progressed and present measures to forward the regional efforts to reach the common goal a resilient society. The 21 CABs agreed upon a set of questions for a survey to the municipalities, in order to map local perceptions, conditions and activities up to date. Contacts through workshops and dialogue completed the pictures. The task is based on an analysis of what regional and local needs are, what has been done so far and how to achieve what is missing. As an important basis for adaption to climate change in Sweden the government has put an effort in producing a high resolution elevation model now covering almost the entire country of Sweden. The distance between adjacent grid points is merely 2 meters and the elevation is given with an average accuracy of 0.5 meters. Different types of analysis have been employed to assess risk areas and activities, thus where the work needs to be started up or intensified. Projections of increased rainfall yield improved conditions for occurrence of land slides. To assess the vulnerability CAB of Blekinge performed GIS analysis combining the soil map with a slope analysis to identify areas with potential for landslides. Through overlay analysis we could delineate vulnerable areas; coincidence with major roads, settlements or buildings, and also coincidence with industries and polluted areas and other environmentally that implies vulnerability for dispersal of hazardous substances in the environment. Another example of risk area identified by several CAB?s concerns flooding of contaminated soil and in the vicinity of activities hazardous to the environment. CAB of Östergötland analysis of GIS-layers have shown to be a useful tool to indicate areas prone to flooding that needs to be upgraded for decontamination. As an example of planning documents, CAB of Skåne developed a GIS-layer showing the amount of houses to be flooded when sea level rise reach 1 meter. For many municipalities spatial planning has shown that in most parts of Sweden it is possible to localize future building outside of risk areas, but risk areas are found in existing urban areas prone for flooding. The high resolution elevation model (HREM) has been useful to analyze risks caused by rising sea level and increased rainfall, and related consequences by flooding, landslides dispersal of hazardous substances from polluted areas. Risk assessments constitutes an important basis to prepare Regional Action Plans.The HREM has shown to be useful in delineating risk zones. A more difficult issue arises when the analysis becomes a planning document that has to take the actual analysis further and into action on a local and regional level: What measures are suitable? What might the indirect effects be? Who is responsible and who will pay?

Översiktlig sårbarhetsanalys - naturolyckor (Länsstyrelsen i Blekinge, rapport 2012:7) Klimateffekter och riskklassning av förorenade områden (Länsstyrelsen i Östergötland, rapport 2014:6) Remissversion Regional handlingsplan för klimatanpassning 2014 (Länsstyrelsen i Skåne, 2014)

Tuesday session 2 – Low probability / high impacts

The perceived need to adapt to climate change in a natural resource dependent community in Northern Norway

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The paper investigates the conditions for adaptation among three occupational groups in a community in Northern Norway and finds that the salience of the adaptation issue is shaped by livelihood rather than exposure to climate change. The salience of the adaptation problem as a precondition for adaptation is so far been neglected in the adaptation literature, which also point to the lack of emphasis on issue salience as a condition for policy change in the broader governance literature (Hovelsrud et al. 2010). There is also an apparent disconnect between the abundance of scientific knowledge about climate change, the overwhelming evidence that such changes are caused by human action and the general societal response and political commitment to deal with the challenges (Hulme 2009, Jasanoff 2010). If society is to adapt to climate change, then the need for adaption must be recognized and it has to be seen as a salient issue among decision-makers. This is a perspective that is lacking in the adaptation to climate change literature. The paper presents how actors in a natural resource dependent community in Lofoten, Northern Norway perceive and respond to changes in weather and resource conditions, as well as projections for future climate. While climate change is projected to substantially influence primary industries, such as fisheries and farming in the northern regions, climate change is not perceived to be an immediate concern when compared to outmigration, jobs, and the social and economic viability of municipalities. This paper argues that the need to adapt is felt differently, if at all, between different actors, such as fishers, farmers and municipal officials in the North. By drawing on the concepts from adaptation to climate change literature and cultural theory, the paper seeks to explain this divergence in perceptions and responses between different actors, by showing how they are shaped by the actors cultural cognition, livelihood and values. Perceptions of risks and the need to act on the basis of scientific knowledge hinge on whether scientific knowledge is viewed as salient, credible and legitimate and on the individuals? risk perception, values and livelihood. If scientific climate change knowledge commands changes at the local level, it is a matter of democracy to involve local stakeholders in both the production and dissemination of knowledge. In addition, assessments and analyses of adaptive capacity need to take the perceived need to adapt into account as a determinant of adaptive capacity.

Hovelsrud,G.K., et al. 2010. Adaptation in Fisheries and Municipalities: Three Communities in Northern Norway. In G.K.Hovelsrud & B.Smit, Community Adaptation and Vulnerability in Arctic Regions. Springer Netherlands. Hulme,M. 2009. Why We Disagree About Climate Change. Cambridge CUP. Jasanoff,S. 2010. A New Climate for Society. Theory, Culture & Society, 27 (2-3), 233?253.

Does publishing of flood risk maps have the intended effects?

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This study assesses whether the publishing of flood risk maps for Finnish cities on internet did lead to price reductions of houses prone to floods. This is assessed for various flood return times in various locations by means of econometric estimations (a difference-in-differences approach). Asymmetric or imperfect information are standard aspects of the housing market, i.e. sellers know more about the considered house than buyers. Publicly available flood risk maps are used as a policy instrument aimed at compensating information gaps and asymmetries. When such ? hitherto not widely known ? information is published (on internet in this case), its impact should be detectable in the housing market. The response of the housing market to such information shocks provides insights into its adaptation capacity to spatially variable risks, and into the responsiveness to new information truly relevant to the value expectations for real estate. We examine the effects of the public disclosure of flood risk maps on housing prices in the housing market of selected Finnish cities with flood prone areas. The considered areas were already built-up areas by the time the flood risk maps were published. The used dataset contains real estate transactions dating from both before and after the publication of the flood risk maps. On the basis of a large real estate transaction data set covering various decades with 1000 to 5000 annual transactions per city control and treatment groups in three different cities (Helsinki, sea flooding; Pori and Rovaniemi, river flooding) were formed. A difference-in-differences methodology (DD) is implemented via DD hedonic regression setups. It should be realized that houses with seaside or riverside views usually enjoy a premium on their prize, which effect even spills over to neighbouring houses without a (direct) seaside or river view (Votsis 2014). Thanks to the adopted method and the abundance of data this premium effect can be distinguished from the risk discount effect. Two kinds of effects following from the flood map publications have been identified. Firstly, the transactions in properties located inside the published flood zones exhibit a statistically significant price drop after the information disclosure. We show that the estimated impacts are free from closely related effects such as proximity to the coast and other hedonic amenities. We also discuss the possible interference of the economic crisis in the estimations. Secondly, the transactions affected by sea flooding information in Helsinki exhibit an additional sensitivity to the communicated return times of flooding. This sensitivity is of modelling and simulation interest, as it can be coupled with future climate projections so as to investigate whether unmitigated climate change reinforced flood risks could affect the urban spatial equilibrium in the housing market. Publication of flood risk maps (on internet) can be effective with respect to correcting house prices in accordance with property risk levels. There was also an indication that in the city with the highest awareness of local flood risks (Pori) the discount was smaller in percentage terms, indicating that the Pori housing market had already to some extent absorbed the flood risk information prior to the publication of the flood risk maps. Even though the available data set covers various years after the flood map publication, it is unsure how persistent the effect of publication of flood maps is.

Votsis, A. (2014), Ecosystems and the spatial morphology of urban residential property value: a multi-scale examination in Finland, MPRA Paper No. 53742, http://mpra.ub.uni-muenchen.de/53742/

Assessing limits of adaptation for ecosystem services under a changing climate in Finland

Carter, Timothy; Finnish Environment Institute (SYKE)
A-LA-CARTE Consortium members; See below

Initial results are presented from a project on ecosystem services in Finland. The project seeks to examine limits of adaptation to anticipated climate change at the high end of climate projections, investigate the extent to which present-day systems are resilient to such changes and explore options for enhancing this resilience. The project addresses these issues through two case studies of important ecosystem services. Case study A is on agrifood systems, focusing on food supply by farms and access to food by consumers. This employs crop and economic models of the production system, indicator analysis and stakeholder survey to analyse how climate change adaptation may improve the capacity of the food chain to respond to consumer demand. For instance, historical adaptation measures and their effect on crop yields have been studied using crop simulation models, with an earlier sowing date shown to have less of an effect on yields than a cultivar change. The effects of cultivar diversification as a farm level adaptation response for building resilience in production are also being examined. Case study B is directed towards biodiversity and conservation challenges posed by physical and regulatory barriers. This investigates the implications of climate change for biodiversity using species and dynamic vegetation modelling (specifically for butterflies and birds), and considers adaptation options available for conservation planning, including legal and economic constraints. For instance, the difference in resilience of protected versus unprotected areas is currently being studied by gathering empirical evidence from a new bird atlas of observed changes in bird distributions relative to those mapped in an earlier atlas. Legal mechanisms include switching from preservationism to more flexible and dynamic conservation and creation of governance institutions that work at different spatio-temporal scales. The attitudes of forest owners towards conservation of biodiversity have also been surveyed. Finally, interactions between the two case studies are also being explored, including an analysis of grassland management for promoting butterfly conservation using a dynamic range expansion simulation model with habitat data to study species dispersal. Constraints on the dispersal of butterflies include habitat fragmentation, physical barriers such as seas, lakes and mountains and susceptibility to increased land use. A-LA-CARTE Consortium members: Suvi Borgström[1,5], Stefan Fronzek[1], Risto K. Heikkinen[1], Janne Heliölä[1], Marja Järvelä[2], Helena Kahiluoto[3], Heikki Lehtonen[3], Xing Liu[3], Olga Mashkina[1], Reijo Miettinen[4], Hanna Mäkinen[3], Kirsi Mäkinen[1], Tapio Määttä[5], Sami Paavola[4], Taru Palosuo[3], Ari Paloviita[2], Nina K. Pirttioja[1], Tuomo Purola[3], Antti Puupponen[2], Juha Pöyry[1], Karoliina Rimhanen[3], Reimund P. Rötter[3], Anna Tainio[1] and Raimo Virkkala[1]

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Climate model uncertainty versus conceptual geological uncertainty in hydrological modelling

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The impact of climate model uncertainty and geological model uncertainty has been assessed for a catchment on Zealand, Denmark, using a physical based and distributed hydrological model. The effects on groundwater heads, stream discharge, travel time and capture zones are evaluated. Projections of climate change impact are associated with a cascade of uncertainties including CO2 emission scenario, climate model, down scaling and impact model. However, the relative importance of the individual uncertainty sources is expected to depend on several factors including the quantity that is projected. In the present study the impact of climate model uncertainty and geological model uncertainty on hydraulic head, stream flow, travel time and capture zone are evaluated. Six versions of a fully distributed coupled surface water/groundwater model based on the MIKE SHE code, each containing a unique interpretation of the geological structure of the model area, are forced by 11 climate model projections. Each projection of future climate is a result of a GCM-RCM model combination (from the ENSEMBLES project) forced by the same CO2 scenario. The changes from the reference period (1991-2010) to the future period (2081- 2100) in projected hydrological variables are evaluated and the effect of the uncertainty on geological model and climate model on the magnitude of the projected change is quantified. For projections of hydraulic head, the uncertainty on the change in hydraulic head from reference to future climate is primarily controlled by the climate model whereas the geology is less important (difference of a factor of five). With respect to stream discharge almost all the uncertainty is caused by the climate model whereas the impact of the geology on the change is insignificant. However, when travel time and capture zone area are considered the geological model uncertainty is much more important for the prediction of changes. The results show that uncertainty propagation is context dependent. While the geological conceptualization is the dominating uncertainty source for projection of travel time and capture zones, the uncertainty on the climate models is more important for groundwater hydraulic heads and stream discharge. Additionally, as the future climate moves away from the baseline, the more sensitive the results are with respect to the conceptual geological model and the higher uncertainty on the projections might be expected.

Seifert, D., T.O. Sonnenborg, J.C. Refsgaard, A.L. Højberg, and L. Troldborg (2012), Assessment of hydrological model predictive ability given multiple conceptual geological models, Water Resources Research., 48, doi:10.1029/2011WR011149.

Investing in climate change adaptation: understanding risk when facing an uncertain future

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Impacts from extreme events are uncertain, costly, and rare. Yet, adaptation measures have to be financed and implemented in the present at a definite cost. There is thus a trade-off between reducing extreme event impacts and the opportunity cost of any investments made. Though the changing climate is expected to make extreme weather events more likely, they remain relatively rare. However, given enough time, a municipality is expected to see impacts from such events. The physical impacts are expected to be more severe if adaptation options are not implemented. This adds complexity to climate change adaptation decisions. Impacts are uncertain and in the future, and while they may be costly, they are also rare events. On the other hand, adaptation measures have to be financed and implemented in the present at a definite cost. Thus, a decision maker is trading the reduction of the magnitude of climate impacts versus the opportunity cost of any investments made. Such a decision space can be modelled stochastically, allowing the assessment of different adaptation investment strategies. A simulation is created that has four components: a stochastic weather generator, an impact calculator, an adaptation simulator, and an investment strategy simulator. First, the stochastic weather generator simulates storm events through time, by selecting from an exogenous long-tailed probability distribution. The distribution is developed from historical weather records and downscaled climate models and evolves to simulate a changing climate, making future extreme events more likely. Second, the impact calculator is based on case study analysis and modeling specific to the municipality under study. Different levels of events are simulated, and they are then analysed in a Geographic Information System (GIS), where the physical impact of buildings, roads, critical infrastructure, and health/mortality are estimated. A regression is used to identify thresholds and construct a statistical relationship between the severity of the event and the level of impacts. These can then be converted to a discounted economic cost (net present value) for each level event. Third, adaptation options are also identified and may include gray options (larger sewer pipes, concrete dykes, etc.), green options (greenways, retention ponds, green roofs, etc.,) or soft options (evacuation training, flood alarms, etc.). Adaptation options are simulated by their cost, their implementation time, their lifetime, and their effectiveness at reducing the impacts. Fourth, the strategy simulator is a set of investment scenarios, including a precautionary approach, a reactionary approach, a flat investment approach, and a highest protection level approach. This analysis allows a comparison between different decision making regimes by different criteria: least cost and highest level of protection. In particular, the focus on how different perceptions and attitudes toward risk can affect the decision making process. The decision making tool is designed to not only test different investment strategies, but also gives a format for understanding and communicating risk. It is set up to flexible to amount of available input data, where modules could be simplified and streamlined accordingly. Different sensitivities can also be performed, such as the uncertainty in the climate change signal, the economic uncertainties, and effectiveness of various adaptation options. This aids in creating more robust decisions for climate change adaptation.

Kaspersen, P.S., K. Halsnæs, J. Gregg, M. Drews (2012). Methodological framework, analytical tool and database for the assessment of climate change impacts, adaptation and vulnerability in Denmark. Climate Change and Sustainable Development Programme (CCSD), Systems Analysis Division, DTU Management Engineering; www.man.dtu.dk/English/About/Reports/20 12.asp

Tuesday session 3 – IPCC AR5; so what now?

Adapting to mitigation policies: Farming in Northern Norway

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Aall, Carlo; Western Norway Research Institute
Olsen, Julia; Nordland Research Institute

Recent findings from studies of the intersection of agriculture and climate change in Northern Norway show that farmers are highly adaptive, both to changing growing conditions and agricultural policies. But farmers perceive changes in climate policy to be a greater challenge than adapting to the consequences of climate change. There are three interlinked aspects which have consequences for farmers? adaptation in the agricultural sector in Northern Norway. First, climate impacts are observed and projected with respect to changing weather conditions including increased growing season, increased and seasonal changes in precipitation, fewer snow days and extreme weather events. Secondly, the regulations and structure of Norwegian agricultural policies, socio-economic, market and operating conditions, the current framework conditions such as subsidies related to area farmed versus yield, and the high national income level have consequences for farming. And lastly, the current Norwegian mitigation policy which considers agriculture as a part of the solution includes tax on agricultural diesel, and fewer incentives for the cultivation of bogs, which is critical for farming in Northern Norway. This adds new challenges for farming in the region. The proposed ban on the cultivation of bogs, to reduce the emissions of methane to the atmosphere has not materialized, but there are restrictions within some municipalities which require fundamental changes in the adaption strategies of Norwegian farming communities. Here we present case studies from Northern Norway in which farmers, interest organizations and the governmental officials have been interviewed. The results are based on a number of projects carried out over a span of six years. The findings show that farmers in our case areas consider climate change to be mainly positive for their activities through longer growing seasons and higher yield. This can be explained by the fact that farming in this region is operating on the margins of what should be possible, being located above the Arctic Circle. On the other hand, climate change may introduce new and different insects or fungi to which the plants are not adapted, and shift in the seasonal climate can affect the timing of different farm operations. There are particular problems caused by increased precipitation and seasons on pastures and farmland in the late autumn or early spring. This combines with the increasing number of farmers who rent land and have to drive longer distances for farming. This requires heavier equipment which is more damaging to the soil. These conditions create boundaries for the agronomical and technical ability to alter agricultural productions. Furthermore, the economic status of the farm and profitability in diversifying productions create additional barriers for the farmers? capacity to alter production, take advantage of new opportunities and thereby adapt to impacts of climate change. Farmers are to a degree vulnerable to a changing climate through the alteration of growing conditions, and climate change is an added factor to a tenuous situation created by Norwegian agricultural policy and socio-economic developments. Farmers, interest organizations and government officials are more concerned with mitigation policies and increased input factors than for climate change. They are concerned that the structural and economic changes will increasingly reduce the number of farms with knock-on effects for global food security. The findings show the interconnectedness of factors that shape farming and the need for cross- sectoral policies addressing both mitigation and climate adaptation.

Kvalvik Ingrid, Sigridur Dalmannsdottir, Halvor Dannevig, Grete Hovelsrud, Lars Rønning, and Eivind Uleberg. 2011. Climate change vulnerability and adaptive capacity in the agricultural sector in Northern Norway. Acta Agricultura Scandinavica. Section B - Soil and Plant Science, Supplement 61: 1 27-37.

Modelling linkages between adaptation and mitigation in the agricultural sector in the Nordic region to inform policy making for effective adaptation

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Termansen, Mette; Aarhus University, Department of Environmental Science, Denmark
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The paper presents an environmental/ecological economic model to examine the extent to which projected future climatic conditions may cause shifts in agricultural land use patterns across the Nordic region. Subsequently, the feedback of such land use shifts to climate change mitigation is quantified and the implications for policy making are discussed. It has been increasingly acknowledged that the agricultural sector faces both opportunities and constraints due to a changing climate, whose direction and magnitude vary from one region to another. Accordingly land managers will need to adapt in different ways to climate change and the associated drivers, which may involve shifts in their agricultural land uses. The extent of such likely land-use changes will certainly be simultaneously shaped by other important factors including the heterogeneous biophysical and socioeconomic characteristics within which land managers operate. Inevitably agricultural adaptation involving land-use changes will in turn have important consequences not only in economic terms (changes in productivity) but also environmentally (changes in carbon sequestration capacity and direct and indirect GHG emissions), which in turn has long term economic implication. In other words, agricultural adaptation to climate change related drivers can have significant effects on the mitigation performance of the agricultural sector. In this paper, we develop a spatially explicit model to investigate the influence of existing climatic variation (along with biophysical and socioeconomic factors) on rural/agricultural land use patterns. The model is then used to explore how projected future changes in climate may trigger important shifts in rural/agricultural land use. The timescale of the modeling extends to up to the year 2060. The fundamental assumption of the model lies on a profit maximization decision making in which, given the circumstances they are in, land managers choose to allocate a certain combination of a particular land area proportion and a particular land use option that would give the highest economic return. The outcomes of the land use change modeling are subsequently used to analyze the GHG emissions both as direct and indirect consequences of the predicted land-use changes. Enforced by the resolution of the accessible data, the spatial units of our analysis correspond to Municipality levels. The model is applied to the Nordic region encompassing four countries (Denmark, Finland, Norway, and Sweden) which represent heterogeneous agricultural production (both types and intensities), biophysical and socioeconomic characteristics, and policy influence. The outcomes of the model are expected to provide important empirical evidence and have the potential to inform effective climate change adaptation strategies for rural/agricultural land use in general and in the Nordic countries in particular. It is anticipated that the model will provide an analytical platform for further investigating the possible consequences of different future scenarios not only in terms of future climate change projection but also in terms of potential environmental and agricultural policy directions.

Bioenergy trade in a changing climate: identifying and adapting to climate vulnerable supply chains

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Bioenergy is expected to be a key component of global mitigation policies. However, from cultivation via logistics to final consumption, supply chains are exposed to climate change. We highlight key aspects to focus on to ensure climate- resilient bioenergy implementation, with special focus on wood-based bioenergy used for heat & power. Bioenergy in the form of wood fuels will play a key role in EU strategies to fulfill the 2020 goal of 20% renewables in energy consumption. One particularly large growth segment is the increased use of wood chips and wood pellets in district heating systems and power stations. Notably, demand for wood pellets in the Western Europe has in recent years risen very sharply as several large power stations have begun to replace coal with wood pellets. Shifting from fossil fuels to renewables is often seen as a positive development when it comes to increasing resilience and improving security of energy supply. However, this is not necessarily the case, especially not when it comes to robustness of energy systems to weather disturbances and climate change. There are several reasons for this. To begin with, all biomass production is inherently exposed to variations in weather conditions and climate change. An example is how Hurricane Gudrun disrupted wood fuel supply systems in Southern Sweden in 2005. Wood fuels are also in general more complex when it comes to logistics. The relatively low volumetric energy density of wood means that a shift from e.g. coal to pellets entails a doubling of transported volumes. Wood fuels are also vulnerable to moisture and pellets tend to dissolve if exposed to water, which complicates storage and handling significantly. Furthermore, heat/power stations located in urban areas have limited space for on-site storage. This leads to supply systems reliant on continuous fuel supply that are sensitive to climate-related disturbances. The issues raised here have so far received very little attention but it is imperative that they are acknowledged and addressed if wood-based bioenergy is to be a successful long-term mitigation strategy. *Climate change will affect all components of the bioenergy supply chain *Bioenergy systems have been implemented widely throughout Europe without these issues being taken into account *We raise these issues and suggest ways to address them

Olsson O. & Johnson F.X. Bioenergy trade in a changing climate" (2014) NORD-STAR Working Paper 2014:1"

Climate-smart cities as catalysts for sustainability: A new look at synthesized adaptation & mitigation planning approaches to climate change

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Extreme weather, the risk of higher temperatures and increased flooding all create new challenges to cities that require adaptive engineering design to provide resilience. However, cities also need to be able to address how climate change impacts the socio-cultural environment, particularly to reduce the risk exposure faced by vulnerable populations. Cities are on the front line of climate change. More than half the world?s population today already lives in cities, and it is expected that more than 75 percent of the population globally will live in cities by 2050. Therefore, it is critical to increase the resilience of both the technical infrastructure and the socio- cultural institutional conditions in cities in order to reduce their vulnerability to shocks from climate change. Cities must now look for ways to turn the climate change challenge into an opportunity to become climate-smart, socially just, sustainable cities. With budgets earmarked for climate change either frozen or declining, cities are often left to choose between spending scarce budgets on either adaptation projects or mitigation projects. Additionally, grand megaprojects in urbanization have often been accused of worsening social inequalities. However, there are cities that have taken a third path by applying synergistic approaches that blend adaptation and mitigation approaches. Does this synergistic approach to adaptation and mitigation help cities become climate-smart in a way that goes beyond just energy systems improvements? Can it address the socio-technical institutional conditions required for a broader societal sustainability transition? Do cities in Sweden taking this synergistic approach share any common characteristics with other cities around the world, such that they can form a common praxis? Has the use of synergistic approaches to climate change also been used as a unique opportunity to rethink how we reproduce socio-technical institutional conditions in urban environments by addressing social inequalities? This paper explores the potential for synergistic adaptation and mitigation approaches to be mainstreamed in climate-smart cities, while paving the way towards a broad-reaching sustainability transition praxis for urbanized spaces. Taking a synergistic approach to adaptation and mitigation in urban environments provides a new approach for addressing the kinds of risk exposures induced by climate change impacts. The commonalities between successful project are both linked to their physical characteristics, as well as the capacity found in their underlying socio- cultural institutional conditions. Some common characteristics found in the successful application of a synergistic approach include the use of creative multi-scale financial incentive schemes, agile governance processes seen to be inclusive by actor-network participants, and a consistent vision espoused in communications from those empowered with project leadership.

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Climate change adaptation in the energy sector: an interview study in European companies and public organisations

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Crawford-Brown, Douglas; Cambridge Centre for Climate Change Mitigation Research (4CMR)
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Energy sector organisations were interviewed regarding their views and strategies on climate change, the impacts of climate change on their decisions and operations, and especially on climate change adaptation. This study provides important information on the needs of potential users of the climate change adaptation toolset to be developed. The Tool-supported Policy Development for regional Adaptation (ToPDAd) is a research project funded by the European Commission. The objective is to find the best strategies for businesses and regional governments to adapt to the expected short term and long term changes in climate. ToPDAd will deliver state-of- the-art socioeconomic methods and tools for an integrated assessment, supporting regional adaptation decision-making. The project will give policy and decision makers in European regions the tools necessary to make informed decisions on how to adapt to climate change, avoiding maladaptation. It concentrates on tourism, transport and energy sectors from which the energy sector is emphasised in this paper. Gathering information on the needs of stakeholders was identified as an important step when developing tools for climate change adaptation related decision-making. Hence, 15 public and private organisations operating in the energy sector were interviewed regarding their views and strategies on climate change, the impacts of climate change on their decisions and operations, and especially on climate change adaptation. The interviews were recorded and analysed. Organisations interviewed are located in Austria, Finland, France, Germany, the Netherlands, Spain, Switzerland or in the UK, although some of them have Europe-wide activities. Altogether 25 question were posed to the stakeholders covering their current and planned strategies, as well as ideas regarding policy, scientific and tool support. For instance, they were asked about how climate change affects their business currently and in the future and how they monitor climate change. In addition, they were asked about EU or state-level policies or support from the science field that would support energy sector decision- making. Finally, the organisations were asked about the characteristics of a decision-support tool that would support their adaptation related decision-making. Most of the stakeholders viewed climate change as mainly a source of negative consequences, however some found also positive consequences. The stakeholders hoped for more predictability, monetary support to the actors, functioning markets, interdisciplinary research and research on more accurate risk estimates from the EU and state-level policies and science field. The decision- support tool should, for instance, offer accurate predictions and probabilities of the most important climate change effects regarding the energy sector (both demand and supply), the effectiveness of adaptation strategies to tackle these effects and climate scenarios up to the regional level.

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Tuesday session 3a - Mainstreaming

Supporting cities to adapt to climate change by using a modular toolkit - first results and lessons learnt

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Jörg Cortekar; Helmholtz-Zentrum Geesthacht - Climate Service Center (CSC)
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The paper presents the concept and general structure of an innovative modular adaptation toolkit for cities as well as some first results and lessons learnt from our work together with the case-study city of Kiel - the capital and most populous city in the northern German state of Schleswig-Holstein. Climate change is heavily supported by evidence and also the EU is already facing unavoidable impacts. Adapting to climate change therefore is necessary, and goes hand-in- hand with an increase in the resilience of social and economic systems. This is especially true for cities, since local authorities, in all socio-economic situations and geographical locations and despite their emissions reduction efforts, are vulnerable to the various impacts of climate change. Cities should be key actors in the implementation of adaptation measures in order to improve the overall resilience of local territories in policy fields such as spatial planning, public health, civil protection, risk management, energy, water supply and the environment. However, adaptation action is not only about avoiding risks. It brings also new opportunities to enhance the quality of life of the citizens, promote sustainable urban development, lower risks from climate change impacts, stimulate investment and innovation, reinforce stakeholder participation and multi-stakeholder cooperation, and should therefore be integrated into urban development and planning practices. But supporting cities in increasing their resilience to the impacts of climate change is highly context specific. It is not only the city specific vulnerability due to its location, structure, inhabitants and operational capability. Equally important is the consideration of the individual backgrounds of the stakeholders involved in the process of adaptation. As an inter- and transdisciplinary topic, the approaches of the different stakeholders involved are very diverse and so are the specific preferences for adaptation. The range of different impacts, backgrounds and stakeholder preferences makes the implementation and transferability of adaptation measures a difficult issue. With the case-study city of Kiel - the capital and most populous city in the northern German state of Schleswig-Holstein with a population of about 250,000 - for the application of this innovative modular toolkit, we learned first of all that enhancement of communication is a prerequisite for the adaptation process. This means an ongoing dialog between different administrative departments as well between all other involved stakeholders. Until this process is successful it is not possible to build consensus about threats and preferences for adaptation measures between the stakeholders. The consensus is defined in the form of a general principle. Also the inventory of existing data is a valuable source for the generation of adaptation relevant knowledge. The most accepted way of increasing adaptive capacity is by introducing the consideration of climate change impacts into the development processes of urban and land-use planners in local authorities. Thereby the win-win-situation" of chosen adaptation measures can also have positive effects on climate change mitigation." In order to respond flexibly to the cities needs, the most important lesson learnt is to have a flexible consultation framework. With its modular concept our toolkit tries to fulfill this aspect. The modules are designed in a way that they can be integrated in existing processes, thus offering efficiency benefits. This leads to broad acceptance in the administration. Currently the focus within the case-study lies on the modules i) climate sensitive urban and land-use management, ii) assessment of compensation measures, iii) thermal comfort of people and iv) climate adaptation guiding principle. The most recent results to be presented during the conference will be from the currently still ongoing work regarding these four modules.

Climate change adaptation of buildings in Norway. Risks, consequences, measures and future research.

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Cecilie Flyen Øyen; SINTEF Building and Infrastructure
Hans Olav Hygen; Norwegian Meteorological Institute

The paper gives a summary of research on climate change adaptation of buildings in Norway. The use of climate models, scenarios and building data in risk and consequence analysis are presented, in addition to results and implemented/recommended incentives and measures. The paper also identifies important topics for further research. The combination of a rugged topography, spread situated buildings and a large span in building practice make both research of climate change risks and consequences and recommendations of measures for buildings in Norway a real challenge. Recent studies show that sea level rise, increased frequencies of extreme weather events, increased precipitation (both total amount and intensity), changes in precipitation patterns in the different seasons, and increased frequencies of landslides and rock slides, will most likely represent the biggest challenges for the building stock. When it comes to other infrastructures, e.g. roads and railways, changes in avalanche patterns should also be highlighted. Sea level rise will have huge economic and cultural consequences, as a large number of buildings are already currently affected by yearly coastal storm surges. As many as 110.000 buildings in Norway are situated very close to present sea level. Further, due to predicted increased amounts of precipitation and a warmer climate, as many as 2.4 million of today?s 4 million buildings in Norway will be situated in a climate zone of high risk of rot decay by the year 2100. Presently, only 615.000 buildings are situated in this climate zone. Other climate parameters like wet winter precipitation, temperature fluctuations around 0 °C, changes in wind patterns, changes in groundwater level, and decrease of permafrost will also add to the increased strain to the built environment. When it comes to climate adaptation of buildings in Norway, the main focus is presently on extreme weather events. However, changes in the impact of everyday weather might have larger economic and social impacts on future building practices in Norway, as these might have to change. The climate scenarios, risks and consequences for buildings in Norway are quite well documented through extensive research. It does however seem to be a lack of awareness among building owners and governmental bodies in initiating actions and proper measures, contributing to institutional vulnerability. Uncertainties in climate models and scenarios might be one of the main reasons for this. As uncertainties are decreasing, one should expect the actual measures to increase. Meanwhile, the implementation rate of such measure is unfortunately low, even if building owners, planners, contractors and the government and local authorities are aware of the increasing risk. Based on these findings, the paper also highlights focus areas for future research that can lead to increased efforts on taking climate change adaptation of buildings into consideration. It seems to be a lack of awareness in initiating actions and proper measures, contributing to institutional vulnerability. As uncertainties are decreasing, one should expect the actual measures to increase. Meanwhile, the implementation rate of such measure is unfortunately low, even if building owners, planners, contractors and the government and local authorities are aware of the increasing risk. Based on this, in addition to the presented research on climate change adaptation of buildings in Norway, the paper also highlights important focus areas for future research.

Almås, A.J. (2013) Climate adaptation and mitigation in the building sector: towards a sustainable built environment. Doctoral thesis, Department of Civil and Transport Engineering, Faculty of Engineering Science and Technology, Norwegian University of Science and Technology (NTNU), Trondheim, NTNU, 2013.

Management, improvement and prevention of flooding of the state roads - a strategy in action

Grauert, Marianne; Danish Road Directorate

Relevant research and the development of climate prediction models show that over the next century, Denmark should be prepared for significant changes in climatic conditions. For this reason the Danish Road Directorate has prepared a strategy for managing climate changes that can affect the national road network. Aim of the strategy Due to intense precipitation, flooding of state roads in Denmark does occur regularly and is foreseen to occur even more often in the future. A new climate change strategy therefore focuses on the effect of more and intense rainfall and with this, increased levels of groundwater, and how the Danish Road Directorate can prepare its initiatives so that the incidence of road closure as a result of flooding can be minimized. The aim of the strategy is to ensure that our actions are undertaken in an economically responsible and efficient manner, within the framework conditions to which the road network is subject to, including the Government and Ministry of Transport's climate protection plan. The main parts of the strategy A socio-economic analysis showed that it is only very seldom economically responsible to rebuild a road section, if it?s vulnerable to flooding. The analysis shows that if there is a short return period on the event, meaning that we have to clean up a lot, some one time investments can be reasonable. But the longer the return period the more economical responsible it is to base the solution on redirecting the drivers and clean up after the flooding. The climate change adaptation strategy is consequently based on three main topics - management, improvement and prevention. Each area is provided with specific themes e.g. (i) Having call-out service ready (ii) Informing road users about the flood (iii) Clearing up quickly (iv) Being part of the strategic road network (v) Analyzing the event (vi) Creating a database of events (vii) Implementing improvements (viii) Cooperating with the relevant authorities (ix) Screening for particularly vulnerable section (x) Participating in legislative work (xi) Exercising prudence in the planning and construction phase (xii) Considering climatic adaption in connection with carriageway widening. (xiii) Focusing on research, and developing methods and knowledge about climatic adaption (xiv) International cooperation and information-sharing in the field. Cooperation with relevant authorities Still, experience tells us that most climatic related events are a combination of several factors and that the road directorate is seldom solely responsible for the flooding. Therefore, cooperation between relevant authorities, such as municipals and suppliers are equally or even the most important action to take. The Danish Road Directorate has performed a strategy with focus on handling the risk of flooding and rising groundwater, and is currently working on action plans and implementation of the strategy in the organisation. Actions are based on subjects within management, improvement, prevention and coorperation.

Link to the climate change adaptation strategy http://www.vejdirektoratet.dk/DA/viden_ og_data/publikationer/Lists/Publikatione r/Attachments/782/klimatilpasningsstrat egi_eng_web.pdf

Are Danish Homeowners Ready to Engage in Integrated Urban Stormwater Management?

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Based on a national survey of urban Danish homeowners we investigate their readiness to engage in integrated stormwater management (IUSM) and thus climate change adaptation. We argue that homeowners need to feel at risk, feel capable to engage and consider themselves at least partly responsible to act before they engage. One of the much debated solutions to handle the increasing risk of stormwater induced flooding in urban areas is IUSM. In IUSM rain and stormwater is considered as a resource rather than a waste product and the objective is to the largest extent possible to emulate the natural water cycle. Elements are to infiltrate, delay, collect and use stormwater above the surface rather than leading it through the sewer systems and thereby produce added value such as biodiversity benefits, recreational value, aquifer recharge etc. in addition to reduced risk of flooding (Rauch et al 2005). While public authorities may have the main responsibility for urban stormwater management private homeowners are important to engage as they own a large part of in particular suburban areas where infiltration and storage can take place. Grothmann and Patt (2005) and Bichard and Kazmierczak (2012) found that risk perception, adaptive capacity and sense of responsibility are main cognitive factors determining whether an individual choses to adapt or not, thus we address these issues in a survey sent out to 6000 homeowners in urban areas in Denmark. Risk perception: Terpstra and Gutteling (2008) found that risk associated with climate change impacts tends to be perceived as low. Also our study shows that risk perception in general is low. Only if respondents have experienced flooding several times they consider there is a risk it might happen again. As for adaptive capacity Bichard and Kazmierczak (2012) found little capacity to act among homeowners in the British context as both economic capacity and knowledge were perceived as limited. Our survey shows, however, that more than half of the respondents already collect or infiltrate rain water and the large majority claim to have or are able to attain sufficient knowledge for action. However they do not collect rainwater to address climate change but for everyday, practical purposes. Among those who do not collect or infiltrate rainwater, economic limitations is stated as a main reason. Responsibility: studies have shown clear positive correlation between the perceived responsibility of private actors and their risk preparedness (Terpstra and Gutteling). The majority of the respondents consider adaptation to be a shared public and private responsibility, however, regarding the use of concrete measures, responsibility is attributed to public authorities indicating some ambiguity in the matter. We can identify both challenges and opportunitiesfor engaging houseowners in IUSM. Perceived risk from climate change is low and is unlikely to induce action among Danish homeowners unless they have been flooded themselves. But how then to motivate houseowners living uphill were the risk of flooding is low, but societal effect may be important? Opportunities are that houseowners attribute some responsibility for adaptation to themselves albeit with modifications, and are quite willing to perceive rainwater as a resource even if they do not necessarily couple water management with adaptation.

Bichard and Kazmierczak (2012) Are homeowners willing to adapt to and mitigate the effects of climatic change? Climatic Change, 112 Grothmann and Patt (2005)Adaptive capacity and human cognition: The process of individual adaptation to climate change. Global Environmental Change, 15:3 Rauch et al (2005)Integrated approaches in urban storm drainage: Where do we stand? Environmental Management, 35:4 Terpstra and Gutteling (2008) Households Perceived Responsibilities in Flood Risk Management in the Netherlands. International Journal of Water Resources Development, 24:4

Adaptation to climate change in the German railway system: the interplay between actors and institutions

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Our empirical analysis shows that the German railway system is not adapted to climate change. Major barriers include an institutional void and a strong orientation to cost-efficiency. Moreover, public and private actors in the system confine responsibilities. Changes in standards and regulations are needed to support adaptation in the railway system. Railway infrastructure is a critical infrastructure, which is characterized by its importance for society as a whole and for a sustainable transport system; its failure may result in both, shortages of supply and dangers to public safety and security. Recent extreme weather events have moreover shown that railway infrastructure is vulnerable to weather events and climate change. Based on the framework of the actor-centered institutionalism (Mayntz & Scharpf 1995; Scharpf 1997) we conducted an exploratory case study on the German railway system. We aimed at identifying how the actors in the system (railway companies, ministry for transport, public authorities) are adapting to climate change and what influences action and decision-making towards a (climate) robust infrastructure. Following the guiding framework we analyzed action situations, institutional setting, actor constellations, and actor orientations. Our empiric approach includes document analysis, sectoral workshops and semi-structured interviews with representatives from the German railway company, the Ministry for Transport and the Federal Railway Authority. The main results of the analysis are: Although the German railway system was severely affected by extreme weather events during the last decade, the different actors have only tentatively started adaptation measures (e.g. improved vegetation management, integration of climate aspects in the environmental impact assessment for new railway constructions), but do not follow a strategic proactive approach to adaptation. Hampering factors can be found in the institutional setting, the actor constellation and the actor orientation: existing institutions in the railway sector do not define responsibilities for decision-making on climate change. On this topic an institutional void prevails. Moreover the different actors have contrasting perceptions how adaptation should proceed and who should be responsible. Interestingly, most actors ask for top-down decision-making while adaptation research often argues for bottom-up approaches for successful adaptation. In addition, existing regulation in the railway sector supports an efficient use of financial resources; consequently all actors show a strong orientation to cost-efficiency that hampers decision making on adaptation. On the other hand, we found that single actors, who have a high willingness to act, are able to use the unclear responsibilities to proactively integrate adaptation issues in existing institutions such as the environmental impact assessment. Our findings show that the current institutional setting, the actor constellation and the actor orientation in the German railway system are not supportive for adaptation. We however find that existing institutions are not per se constraints to adaptation but may be changed by the actors in the system. We conclude that changes in standards (ISO, CEN, DIN etc.) and in regulation (e.g. integrate climate proofing in financing mechanisms for new railway constructions and railway maintenance) are needed to support adaptation measures in the German railway sector. Moreover a political or public debate on the desired robustness and corresponding willingness to pay is necessary to develop adaptation goals for the sector.

Mayntz, Renate, and Fritz W. Scharpf (1995): Der Ansatz des akteurzentrierten Institutionalismus. In Gesellschaftliche Selbstregelung und politische Steuerung, ed by. Renate Mayntz and Fritz W. Scharpf, S. 39?72. Frankfurt/ New York: Campus Verlag. Scharpf, Fritz W. (1997): Games Real Actors Play: Actor-centered Institutionalism In Policy Research. Oxford: Westview Press.

Tuesday session 3b - Mainstreaming

Identifying and assessing policy coherence in climate adaptation in Denmark, Finland and Germany

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This paper identifies and assesses policy mixes implemented to address climate change adaptation in selected sectors in three EU Member States. We map and characterize the intervention logic embedded in policy instruments for climate change adaptation to assess whether adaptation policies are coherent with other policies within these sectors. Strategic policy documents including the 2009 EU White Paper on Adaptation, the 2010 Cancun Adaptation Framework and the 2013 EU Strategy on climate adaptation identify climate adaptation as a necessary complement to mitigation. Cost effective and efficient climate adaptation is of key relevance, together with the enhancement of market opportunities and innovation (Europe 2020 goals, the 2050 Road Map). Climate change adaptation cuts across multiple sectors and therefore requires an integrated policy strategy, while procedures for addressing cross- sectoral issues often lack coherence (OECD Policy Brief October 2002). Moreover, the development of policies to tackle a new problem, such as climate adaptation, interacts and may even conflict with existing policies within policy sectors, deepening the problem of coherence. The paper analyses the policy coherence of adaptation policies and other policies within selected sectors. Nilsson et al. (2012: 395) define policy coherence as an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives?. Analytical frameworks for assessing policy coherence and integration have been developed (e.g. Nilsson 2012, Runhaar 2014), but empirical evidence, in particular through comparative studies, is still sparse. This paper identifies and assesses policy mixes (e.g. Howlett and Rayner 2007; Flanagan et al. 2011) implemented to address climate change adaptation in selected sectors in three of the traditionally leading member states in EU environmental policy: Denmark, Finland and Germany (Liefferink & Andersen 1997). We map and characterize the intervention logic (e.g. Vedung 2009) embedded in policy instruments for climate change adaptation implemented in selected national sectors to assess whether climate adaptation policies within these sectors are coherent with other policies in the sector. In order to assess the policy coherence we apply a three- step-policy-coherence-framework developed by Nilsson et al. (2012): i) inventory of policy objectives, ii) screening matrix (mapping of interactions between main areas of sectoral policy activity and climate adaptation policies), and iii) in-depth mapping of key interactions. As part of the discussion on coherent policy instruments, we discuss the distinction between instruments aiming to encourage private action versus instruments aiming at public action in order to examine how the interface between public and private responsibilities is conceptualized. Furthermore, we discuss how the time frame and the logic of intervention of adaptation measures affect conclusions concerning the consistency of instruments. The analysis is based on literature and policy documents analysis and interviews with key stakeholders/policy makers. [Difficult to say at this stage as this is work in progress] We expect to be able to assess whether climate adaptation policies within the selected sectors are coherent with other policies within the sectors. In order to assess the policy coherence we apply the Nilsson et al (2012) three-step-policy-coherence- framework. Furthermore, we expect to be able to discuss the distinction between instruments aiming to encourage private action versus instruments aiming at public action, and to discuss, how the time frame and the logic of intervention of adaptation measures affect conclusions concerning the consistency of instruments.

Nilsson, M., T.Zamparutti, J.E.Petersen, B.Nykvist, P.Rudberg & J.McGuinn, 2012, 'Understanding Policy Coherence: Analytical Framework and Examples of Sector- Environment Policy Interactions in the EU' Environmental Policy and Governance 22:395-423. Runhaar, H., P.Driessen & C.Uittenbroek, 2014, 'Towards a Systematic Framework for the Analysis of Environmental Policy Integration' in Environmental Policy and Governance.

Integration of Climate Adaptation Policy across levels of policy making and the adaptive capacity of local government in Denmark

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Increasingly, the need for integration of climate adaptation policy (CPI) in relevant sectors and across levels of policy making is recognized. Moreover, the capacity of national and local governments for developing robust, flexible and coherent adaptation strategies is in focus, while this capacity is, also, dependent on the extent of adaptation CPI and contextualized co-benefits of adaptive policy. Danish local governments have developed climate adaptation plans, and this paper examines the impact of CPI and adaptive capacity on these. In recent years, the impacts of climate changes have prompted policy responses that address vulnerability, risks and social impacts of climate changes, as well as the direct and indirect costs related to non-adaptation and to policy actions aimed at promoting social and economic adaption, as reflected in the EU Strategy for Adapting to Climate Change (2013). The EU adaptation strategy stresses that climate adaptation should be integrated into other policy sectors and that coherence with other policy objectives and coordination of policy objectives, measures and issues across policy sectors are vital for successful development and implementation of climate adaptation policy, and thus for reduction of the vulnerabilities of cities and societies to the impacts of a changing climate at short, medium and long term. Policy actions at local scale are here recognized as important for successful implementation of adaptation objectives and strategies. Moreover, the direct effects of climate change, such as flooding and draught are experienced at the local level, as are the benefits of timely adaptation, ensuring a higher degree of scale congruence for costs and benefits than is the case for climate mitigation. At the same time, institutional capacity including knowledge, leadership and resources to manage the impacts of climate changes vary among local governments, and adaptation competes with other pressing issues on local policy agendas. Moreover, the specific ways in which climate adaptation policy objectives are integrated into other policy areas vary locally. Given the importance of the local level for climate adaptation, it is important to understand the determinants of whether EU and national adaptation policy objectives are successfully implemented at the local level. This paper investigates the capacity of local government for managing the challenges of integrating and implementing climate adaptation policy objectives, focusing on the importance of institutional context. We examine what - and how - institutional factors affect the capacity of local government to adapt to climate change and to integrate climate adaptation policy into other policies. . The study builds on climate policy integration (CPI) (Adelle and Russell, 2013) and adaptive capacity (Dodman and Satterthwaite, 2008) (Dodman and Satterthwaite, 2008; Smit and Wandel, 2006) as analytical framework for the analysis. The paper is based on a study of Danish municipalities while these were preparing the mandatory local climate adaptation plans. Data was collected through a qualitative comparative case study of three municipalities, and through a survey conducted among all Danish municipalities. The results indicate that leadership, institutional ability to readjust and see major challenges as strategic options and a critical level of knowledge and skills within key adaptation areas are major determinants not only of integration of climate adaptation policy issues but also of developing local capacities or managing the impacts of climate changes, i.e. institutional adaptive capacity.

Adelle, C., Russel , D., 2013: Climate Policy Integration: a Case of Déjà Vu?, Environmental Policy and Governance, 23: 1?12 Dodman, D. D. Satterthwaite (2008). Institutional Capacity, Climate Change Adaptation and the Urban Poor." IDS Bulletin 39(4): 67-74. Smit, B., J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16:282? 292. "

Indicators to monitor climate change adaptation: an approach and lessons from Scotland.

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Countries across the globe are developing and implementing climate change adaptation policies and programmes. The monitoring and evaluation of adaptation actions has become a critical challenge. This paper sets out a risk based approach used to guide the selection of climate change adaptation indicators, to monitor national adaptation progress in Scotland. The monitoring and evaluation of climate change adaptation is important for a number of reasons :- i) there is relatively rudimentary understanding of effective adaptations, ii) adaptation actions are dynamic as they evolve in response to change, iii) the realisation of adaptation outcomes occurs over long time frames, iv) different adaptations are likely to be required in different situations. The monitoring and evaluation of adaptation is therefore a particularly challenging issue, in part due to these factors, but also because of the complex and cross-sectoral nature of adaptation decision making and action. Given that countries across the world initiating adaptation policies and programmes, there is urgency to the question of 'how can we effectively monitor adaptation'?. In Scotland there has been a strong impetus for climate change policy and action - the country aims to be a world leader in tackling climate change and the Climate Change (Scotland) Act 2009 creates a legally binding framework for the development of climate change policies. In relation to adaptation, the Act contains a requirement for the Scottish Government to ensure both a Climate Change Risk Assessment (CCRA) and a Scottish Climate Change Adaptation Programme (SCCAP) are developed and published every five years. The Act also establishes a monitoring and evaluation framework for the SCCAP comprising annual progress reports and independent scrutiny. A risk based approach to adaptation monitoring is being used in Scotland, where indicators are established to assess the implementation and effectiveness of climate change adaptation at the national scale. Critical to the approach is the use of i) indicators of risk/opportunity and ii) indicators of impact, in conjunction with iii) indicators of adaptation action, to monitor and understand the effectiveness of adaptation activities. The selection of indicators demonstrated in this paper is driven by the need to respond to the climate change risks and opportunities identified by the CCRA and addressed in the SCCAP, and which are spread across the themes of ?Natural Environment?, ?Buildings and Infrastructure Networks? and ?Society?. When selecting climate change adaptation indicators it is important i) to be clear about their purpose, ii) to quality assess their fitness for purpose and the quality of their underpinning data, iii) to balance conceptual ideals with the practical reality of data availability, iv) to link monitoring from different spatial scales and v) to use qualitative as well as quantitative data. Key challenges in the monitoring of adaptation and in the development of indicators are ? i) the setting of targets for adaptation, ii) understanding and encouraging cross sector decision making, identifying and filling data gaps, iii) communicating indicators and trends, and iv) engaging with and achieving buy-in of stakeholders.

National adaptation policy processes across Europe

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This work presents the most comprehensive assessment and dataset of adaptation policy processes in Europe to date. It aims primarily to inform and support the work of policymakers who are coordinating adaptation policy or will be in the future. It also targets actors involved in policy development in sectors which are vulnerable to climate change. It is therefore of particular relevance to national, regional and local authorities, but will also be of interest to utilities (e.g. water, energy, transport) and to other private stakeholders involved in adaptation actions. Climate change is a reality. Impacts vary across Europe depending on climate, geographic and socioeconomic conditions. All the countries are exposed to climate change and this is expected to increase in future (IPCC, 2013). Climate change projected effects are serious and potentially very costly for European countries and their citizens, businesses, regions and cities. However, some regions are more at risk than others (EC, 2013a). A major challenge for public policy will be to adapt our economy and society to the effects of climate change, and even take advantage of the opportunities it presents. Fortunately, adaptation responses are possible and some are already being implemented across Europe. European countries are progressing in planning and implementing adaptation across all levels of government, and as of today 18 have adopted national adaptation strategies (11 more than in 2008) and 15 have developed a national action plan to further define actions for implementation. In April 2013, the European Commission adopted an EU Strategy on Adaptation to Climate Change with the first of its eight actions relating to encourage all Member States to adopt comprehensive adaptation strategies. It is therefore important to provide up-to-date, reliable and targeted information and data to support the development and implementation of these policies and well informed and timely decision-making across all levels of governance in Europe. The rationale for this report is a context of limited information about adaptation activities in European countries. A survey was created because the information currently available is not sufficient to allow for in-depth assessments, for example about good adaptation practices or key factors for success or failure of adaptation. European countries are eager to learn from each other, and the EEA therefore saw an opportunity to facilitate this learning and further strengthen the knowledge base by conducting a survey on adaptation responses in European countries. This report therefore seeks to share experiences, lessons learned and good practices in adaptation. Responses to a survey sent by the EEA to its 32 member countries in May 2013 (and to Croatia in July 2013) are the basis of this report. The survey, to be filled in on a voluntary basis, took the form of an online self-assessment, with countries assessing themselves on their level of advancement in adaptation across a broad range of topics through a series of 44 questions (see details in Annex 1). The self-assessment survey received coordinated responses from 28 countries and thus offers a unique set of information with a large number of European countries covered. This report presents the most comprehensive assessment and dataset of adaptation policy processes in Europe to date. It aims primarily to inform and support the work of policymakers who are coordinating adaptation policy or will be in the future. It also targets actors involved in policy development in sectors which are vulnerable to climate change. It is therefore of particular relevance to national, regional and local authorities, but will also be of interest to utilities (e.g. water, energy, transport) and to other private stakeholders involved in adaptation actions. The focus lies on the advancement of adaptation policy at national and sub- national levels and on supporting the implementation of the EU Strategy on Adaptation to Climate Change in Member States . By expanding the knowledge base for policy development and implementation, it is hoped that this will facilitate decision-making processes across Europe and stimulate long-term transitions and systemic change towards a resilient Europe . This analysis also complements the information available on the European Climate Adaptation Platform (Climate- ADAPT; http://climate-adapt.eea.europa.eu/) and those available at national level, and the recently published EEA reports on Climate change in Europe (EEA, 2013), Climate change, impacts and vulnerability in Europe ? An indicator-based report (EEA, 2012b) and Urban adaptation to climate change in Europe (EEA, 2012a), which provided the scientific

and analytical background information on climate change risks across European regions as well as the policymaking and empirical perspective on adaptation. Countries across Europe are progressing in planning and implementing adaptation across all levels of government. As of today, 18 have adopted national adaptation strategies (11 more than in 2008); 15 countries have also developed a national action plan to further define actions for implementation (EEA, 2014 (forthcoming)). Most European countries report that the level of public awareness regarding the need for adaptation has increased during the past five years and that adaptation has reached the national political agenda. The triggers for adaptation most reported by national governments are observed extreme weather events, estimates of current and future damage costs, the development of EU policies and pertinent results from scientific research. The identification and assessment of adaptation options is often based on expert judgement combined with other methodological approaches such as participatory processes. Stakeholders outside central government (e.g. sub- national governments, private sector, interest groups, researchers and the general public) are usually involved in the development of national policies. Shared natural resources such as transboundary watercourses have motivated transnational cooperation in adaptation, which has often emerged with the support of European funding instruments and in the context of established cooperation fora such as European regional conventions. The knowledge base for adaptation has increased in the last five years. Climate change risk or vulnerability assessments are available for 21 European countries. However, more information is still needed, particularly on the estimation of costs and benefits of different adaptation options, considering relevant uncertainties. Risk and vulnerability assessments are also needed at the local level. Implementing adaptation is still at an early stage across Europe, including at the city level (EU 2013 ? EU Cities Adapt). Most progress has been reported for the water and agriculture sectors, primarily by mainstreaming of adaptation in sector policies. Four European countries are currently implementing a monitoring, reporting or evaluation (MRE) scheme. In addition, nine countries report that they have already developed, or are developing indicators on climate impacts, risks or adaptation.

European Environment Agency (2013), Adaptation in Europe, http://www.eea.europa.eu/publications/adaptation-in-europe European Environment Agency (2014; forthcoming), National adaptation policy processes across Europe

Database support systems for adaptation to climate change: an assessment of web-based portals across scales

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There are globally a rather limited number of case studies available in the portals and few include cost-benefit analysis participation analysis. Portals are rarely cited by researchers suggesting a suboptimal connection between the practical, policy and science development of adaptation. There is no link or search result between the major U.S. and EU portals. Increasing greenhouse gas emissions means adaptation to a changing climate is becoming increasingly urgent. This is widely recognized and policies are being developed and implemented worldwide, across sectors, and between governmental scales most notably in the European Union (EU) and at a nascent stage in the U.S. The aim of this paper is to reflect on the policy developments in EU and U.S. and in particular on one of the major challenges in both regions: facilitating and sharing of information on best practice. Web portals for information dissemination are important tools in meeting this challenge and therefore we assessed the characteristics of selected major portals across multiple scales. We found that there is a rather limited number of case studies available in the portals, in total between 900 and 1000 - with 86 including cost-benefit analysis and 195 including the participation of stakeholders, globally. There were more case studies available via the U.S. portals than via the main EU portal. Portals are rarely cited by researchers suggesting a suboptimal connection between the practical, policy and science development of adaptation. The portals outside the EU are mostly not inter-linked and there is no link or search result between the major U.S. and EU portals. With significant investments and policy developments emerging in both U.S. and EU there is a large potential to share information via portals. There is moreover a potential to better connect the practical adaptation experience from bottom-up projects with the science of adaptation. There is clearly a need for better information sharing with regards to adaptation, especially with regards to decision and policy making relevant information e.g. on implementation/participation and regarding the economics of adaptation. There is moreover, clearly a need to connect praxis oriented research from real world case studies and policy making and the scientific research in adaptation. Moreover, there is a need to share adaptation information on a global scale and certainly between the EU and U.S. with rather similar climate change induced increasing risks and socioeconomic settings, e.g. by linking portals to start with. Similarly, other regions should also combine or link e.g. for drought-prone, flooding-prone regions and countries; countries with similar socioeconomic and political status, etc. weADAPT can be seen an example of this. We have covered the portals that cover key elements of climate change impact, vulnerability and adaptive capacity with a focus on the currently most relevant ones in this paper. It is an additional and active research step to make the portal salient for those who may need information in drafting and implementing policies, or planning and executing measures that improve adaptive capacity locally or regionally (Kirchoff et al. 2013). The active use of a core group of adaptation planners may, in terms of impacts on adaptation strategies, be more important than a fleeting interest from a wide general audience, which is not caught by a review of the rankings, and which was not attempted to be reflected by the rankings. There is an obvious potential for making interesting comparative analyses of the contents, development and use of portals between countries and in particular across the Atlantic, and to share learnings and link resources between the EU and the U.S., especially in light of the ongoing Climate-ADAPT and CDI initiatives in the EU and U.S., respectively. It is moreover quite clear that effective and empirically- and science-based adaptation is needed in light of the CO2 emission gap, and the relatively few case studies addressing core decision-relevant information (Kirchhoff et al. 2013) such as cost-benefit and applicability/participation experiences in the field of adaptation. It is moreover, our hope that this paper can

further facilitate covering the science gaps identified by Moss et al (2013) by pointing to the largest clusters of case studies available globally in this paper.

Kirchoff CJ, Lemos MC, Dessai S 2013. Actionable knowledge for environmental decision making: Broadening the usability of climate science. Annu. Rev. Environ. Resour. 38:393?414. Moss RH, Meehl GA, Lemos MC et al 2013. Hell and high water: Practice relevant adaptation science. Science 342: 696-698.

Tuesday session 3 – Limits and oppertunities

Citizen valuations for climate change adaptation in three municipalities in southwestern Scania

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It is essential for smart adaptation to identify which places are important to the inhabitants and why they are important. A specially constructed questionnaire was used to do that for three Swedish municipalities. Here we present results from the study and illustrate how they can be used for smart adaptation. According to the latest report from IPCC WII (IPCC 2014), Scandinavia can with high certainty expect rising temperatures, rising sea level, overall increase in storm surges and increased precipitation including an increase in extreme precipitation (though in southern Scandinavia a decrease in precipitation is expected in the summer). These effects will in turn give rise to a multitude of societal effects. The societal effects are less well understood (IPCC 2014) but the same report projects with different degrees of certainty, negative effects on for instance ports, buildings, including historically important buildings, infrastructure and human health. Also biodiversity is projected to suffer from effects of climate change. Scandinavian municipalities are to a varying extent working on adaptation plans relating to the projected impacts. In order for the adaptation to be successful, the valuations of the inhabitants must be considered by the planners. A more thorough understanding of the valuations of the inhabitants of affected areas is crucial both for understanding how the climate change will affect the society and for taking the proper adaptation measures. Understanding and protecting the interests of the inhabitants in planning for climate change adaptation is not always straightforward, however. In this paper we present the results of a pilot study were we aim to find out not only which places are most valued by the inhabitants but also how and why they value them. Some places may carry inherent value to the inhabitants and are therefore not substitutable. Other places may be valued because of some property that can also be found elsewhere, which means the loss of these places can be compensated by protecting or creating new areas with the same values. It is also important to know for instance if a place is valued because of its sea view, which makes it improper to protect it by building a dike. Another place might be valued primarily because of its closeness to where people live, which makes it improper to move it or to substitute it with another place further away. By using a special questionnaire structure, constructed for this particular task, we have surveyed the valuations relating to climate change impacts and adaptation among inhabitants in three municipalities in southwestern Scania. The study is based on a survey where 245 respondents answered questions about which place in the municipality they thought were most important places in the municipality and why. To show the usefulness of this type of information and the survey structure behind it, we will present and explain both the survey structure and the results of the survey. The results will be presented in the form of basic statistics about the values relating to climate change among the inhabitants in three municipalities in south western Scania, and in the form of an example of how the results can be used to in adaptation planning.

IPCC WGII AR5 (2014) Climate Change 2014: Impacts, Adaptation, and Vulnerability

Influence of citizens and stakeholders in real-life adaptation policy - opportunities and barriers

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Kalundborg Municipality has carried out a path-breaking participatory approach to prepare for a Climate Change Adaptation Plan. Now the adaptation plan is ready to be finally adopted. This timing allows for a unique opportunity to study whether and how the participatory process managed to influence the adaptation plan. Kalundborg Municipality at the west coast of Zealand, Denmark, has together with the Danish Board of Technology (DBT) carried out a thorough and path-breaking participatory approach with local stakeholders and citizens to prepare for a municipal Climate Change Adaptation Plan. The participatory effort was part of the EU-Interreg project ?BaltCICA? on climate adaptation in the Baltic Sea Region running from 2009 ? 2012 and it included among other things a two-day scenario workshop and a citizens´ summit. After concluding the BaltCICA project, Kalundborg Municipality did continue to work to formulate their municipality adaptation plan. In 2012 a new central-left national government initiated a new law which states that all Danish municipalities would had to prepare an adaptation plan before the end of 2013. This gave new impetus to the work and Kalundborg followed the same schedule as other municipalities, but was far better prepared for the task. The law established that adaptation is a matter of municipal planning and climate change adaptation plans should, henceforth, fit into the 12-year municipal planning period and should be integrated into the overall municipal plans, either directly, or as an appendix. In the beginning of 2014 the proposed Climate Change Adaptation Plan from Kalundborg has been through a local public consultation phase ?hearing?, and the adaptation plan is now on the political agenda at the municipal council to be finally adopted. This timing allows for a unique opportunity to study whether and how the participatory process did succeed to influence the final adaptation plan. DBT is currently partner in the European FP7 project, BASE 'Bottom-up Climate Adaptation Strategies towards a Sustainable Europe', and as a part of this DBT is revisiting Kalundborg in order to make a retrospective view at the different participatory aspects of the decision-making process that was carried out and how these manage to make their mark on the final adaptation plan. The study focus on how the municipality has been able to incorporate local views and suggestions into their short- and long-term adaptation planning. And whether the comprehensive involvements manage to strengthen the adaptation effort and how the political level has prioritized such local input in the final plan. Although open to local interpretation, the Danish democratic and associative tradition prescribes an anticipation of involving affected citizens and stakeholders in planning and policy efforts. This is often the case with long-term planning involving a high degree of uncertainty or risk, as with climate adaptation. Since the regulatory system dictates that political processes are the primary focus of involvement, there are pitfalls for participation, concerning climate change adaptation planning. The type of planning that goes into climate change adaptation is often of a political nature, although it may seem only technical in nature to the people making them, which is a potential challenge concerning participation and involvement. The participatory process did in fact succeed to influence the municipal adaptation plan. The process contributed to frame the work of formulating the adaptation plan and the participatory process and results from the process are referred to in regard to various issues in the plan. Certain controversial issues are only brought forward in the plan because the topics have matured through the participatory process. A properly organized participatory process in a municipality can thus have a major impact on the final adaptation policy.

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Taking science-stakeholder cooperation one step further: Experiences from the Swedish forest sector

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Åsa Gerger Swartling; Stockholm Environment Institute

The importance of integrating stakeholders and decision makers and their needs into adaptation research has been growing in awareness in the latest years. Mistra-SWECIA presents one way to further engage stakeholders and decision makers directly in the research, which will also promote learning between knowledge producers and users. The Swedish research programme on climate, impacts and adaptation Mistra-SWECIA, was launched in 2008 in the aftermath of a devastating hurricane and Sweden's first governmental inquiry on climate change. In the project's Phase I, research on climate scenarios and impact assessments were complemented by participatory research involving stakeholders of the forestry sector. One of the key insights from the user- oriented research in Phase I was that it is very difficult to combine research on adaptation, with support for adaptation. Roles tend to get mixed up and stakeholder expectations tend not to be fulfilled. Mistra-SWECIA´s approach to address this problem has been to create a specific platform that are not tied to a particular research agenda aiming at scientific publications, but that instead put the needs of the stakeholders up front, together with the need to create user value. The platform provides and enables an environment for engagement of policy communities as well as communities of practice in research, focusing on the forest sector. Such engagement and interactions between science, policy and practice offer a demand driven, problem-based and socially relevant approach. The platform has a common agenda and shared responsibility between researchers and practitioners, to solve the specific questions identified by users and scientists together. During the two years the platform has been up and running, a network of practitioners has been engaged and a number of activities and studies has been jointly identified and initiated, which will be presented on the poster. In addition to the joint platform, the Mistra-SWECIA research on adaptation processes also targets stakeholders within the forestry sector. The participatory research includes a number of methods, for example focus group interviews and a quantitative survey. It also engages researchers from various disciplines within the programme, as part of the multi- disciplinary approach. On the agenda is to explore stakeholder values, preferences and risk perceptions regarding climate change adaptation. The research also provides better understanding of stakeholder knowledge needs and use of scientific knowledge. In addition, the research promotes learning between knowledge producers and users and fosters networks. The participatory research within Phase II of Mistra-SWECIA is expected to foster a science- stakeholder dialogue that more directly addresses stakeholder's questions and needs, without compromising the research agenda. This poster will present experiences and specific outcomes of the stakeholder involved research as well as the collaborative work so far and how it has been fruitful for both researchers and stakeholders. Experiences from Mistra-SWECIA strongly suggest that adaptation research needs to become more interactive and practice-orientated in order to create greater engagement among relevant stakeholders within adaptation. Future adaptation research should engage both scientists and stakeholders in a process of co-production of knowledge and joint development of research questions. This requires adaptation research to be conducted in multiple steps giving scientists and stakeholders? time and space for co-evaluating the research process and findings, assess adaptation needs and build mutual trust. The science-practice-policy interface is one way to empower stakeholders and promote co-ordinated and well informed assessments and adaptation actions.

Vulturius G., Gerger Swartling Å ., 2013 Transformative Learning and Engagement with Climate Change Adaptation: Experiences with Sweden's Forestry Sector, SEI Working Paper 2013-12 André, K., L. Simonsson, Å . Gerger Swartling, B.-O. Linnér, 2012, Method Development for Identifying and Analysing Stakeholders in Climate Change Adaptation Processes, Journal of Environmental Policy & Planning, 14

Regimes of value - climate change adaptation and the handling of water in urban landscapes

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Climate change adaptation and handling of water will strongly influence our urban landscapes. How can CCA be oriented not to detract from the value of urban landscapes but to add value in order to create environmental and societal benefits? This research project approach the concept of added-value through pragmatic sociology and landscape architecture Climate change adaptation (CCA) and the handling of water (HOW) will have major impacts on our urban landscapes. How can such influences be oriented not to detract from the value of urban landscapes as mere reactive adaptation, but to add value to them so that they become better landscapes and a societal benefit? Seen in the light of climate change prognosis, CCA and HOW are necessary interventions, but they are also potentials to achieve added value in our surroundings and thus society. This is the basic viewpoint of my research. Values, however, are relational and contextual dependent. Different actors see them differently from their varying agencies and fields of interest in our urban landscapes. The potentials of added value thus also contain potentials of conflict. How can we, despite of this, discuss, define and come to some agreement about values? How can we bridge fields of value to develop added value in a practice-oriented context of CCA? This paper proposes the approach of Thévenot and Boltanski to engage with this issue. They present a way of identifying and justifying values with their 6 Regimes of Justification : the inspirational, the market, the industrial, the opinion, the domestic and the civic regimes. These regimes can provide a methodological approach to clarifying, decoding and encoding values, which can allow mutual understanding and help to reach for collaborative and contextual developments of added-value. The outset of the research is practice oriented: If we should be able to unfold the potentials of added value in CCA projects within a reasonable economical frame ? then we have to engage in the very early processes of CCA projects. Furthermore, traditional boundaries have to be crossed in order to inform CCA results and benefits. The 6 regimes of justification are used as a frame to engage with different actors and address added value in the early processes. This paper presents some further principal argument for this approach, which then in my research project is being explored through CCA/HOW case studies and workshops. The case studies consist of on-going cases involving different actors as e.g. municipality, water company and advisors. The approach of the 6 regimes of justification and added value in relation CCA/HOW is furthermore explored through a series of workshops involving different actors from both practice, architect students as well as high school students. The overall objective is to engage with the field of CCA by a practice-oriented approach focused on connectivity between research and actors. The 6 regimes of justification are explored as a first approach to connect actors and knowledge within the concept of values. The aim is to develop methods to create or facilitate contextually based CCA/HOW and added value by engaging transdisciplinary and transsectoral, in order to work towards resilience and societal and environmental benefits as a long term value in itself.

The 6 regimes of justification: Luc Boltanski og Laurent Thévenot, De la justification. Les économies de la grandeur. Éditions Gallimard. Paris. 1991

Decision making in high-stake, low-probability climatic events Looking beyond standard economics to explain relevant behavioral anomalies

von Bülow, Catharina; CRES & DTU Management Engineering

High-stake, low-probability climatic events set the stage for decision-makers falling prey to biases and inter-dependencies. This paper explains decision-makers anomalous adaptation behavior through the glass of behavioral economics. In so doing, it sheds light on some significant developments in decision-making that have occurred in economics in the last few decades. Climate change research has become increasingly interdisciplinary. The literature in the area, including landmark reports such as the IPCC reports and the Stern review, have progressively presented how economics contributes to the research. Frequently, what is covered in such reports includes risk, decision making, cost benefit analysis and other formidable analytical tools. The models these are founded upon are appealingly logical and elegant. Thus, as a researcher, one can easily become captivated by economists classical recommendation for decisions involving risk and uncertainty and disregard that such decisions are not being made by the economic man -Homo economicus- described in these models. Thereby, neglecting that the real decision-maker is not this perfectly rational and self- interested agent; that when confronted with a decision under uncertainty he relies on simple heuristics which are a direct reflection of his cognitive limitations and biases; or that the intricate inter- dependencies of the world lead him to exhibit other-regarding preferences. This paper proposes that such behavioral deviations from standard economic assumptions should be acknowledged and further investigated. As is often the case with inter-disciplinary studies, researchers have an inclination to limit themselves to drawing from the theories that make up the founding blocks, i.e. standard economics, and fail to follow the evolution or the emerging branches of the discipline as well, i.e. prospect theory, present bias, inequity aversion and other theories that have undergone the neo-classical repair shop". In an attempt to contribute to the correction of this tendency, the paper offers a new perspective to climate change researchers interested in drawing from behavioral (and experimental) economic theories. It provides an intuitive introduction to a wide range of relevant behavioral anomalies. The paper starts from the perspective of the individual and the cognitive traits that lead him astray from efficient climate change adaptation. Then it moves on to group dynamics, where other-regarding preferences affect the efficient outcome. These are exemplified throughout the paper in a climate change setting, though the focus may be on one particular anomaly, i.e. over- or under- updating probabilities subject to the type of risk exposure. Overall, the paper should help enable researchers make key economic assumptions more realistically and ultimately achieve a more powerful economic analysis. "The real world decision maker has intuitive and analytic thinking skills that work proficiently, most of the time. But when facing high-stake, low-probability climatic events his mode of thinking may well lead him to exhibit behavioral anomalies such as loss aversion, ambiguity aversion, myopia, pre- commitment preference, over- or under-updating, coordination failure and inequity aversion. Though, much of the knowledge of behavioral anomalies has yet to be translated from research into actionable decision-making, the paper presents useful tools for researchers who believe that improving decision making lies in the careful empirical study of how decisions are actually made.

-Alpizar, F. et al (2011): Ecological Economics -Casari, M. (2009): Journal of Risk and Uncertainty -Fehr, E. and Schmidt, K. (1999): The Quarterly Journal of Economics -Kahneman, D. and Tversky, A. (1979): Econometrica -Michael-Kerjan, E and Slovic (eds)

Plenary: Low probability / high impacts

Cool it: turning up the heat

Jens Hesselbjerg Christensen; Director, Centre for Regional Change in the Earth System; Danish Meteorological Institute

The most recent report of the Intergovernmental Panel on Climate Change (IPCC) accumulates amble of evidence that human activity is responsible for most of the Global Warming we have witnessed since the 50s. The recent World Summits set up to work out a solution to Global Warming have added up to a (now) long list of unsuccessful attempts to solve the Climate Change problem. This list has spawned local and decentralized initiatives to mitigate GHG emissions, which only now are planned to be coordinated in a top-down regulative approach, but also actions to initiate climate adaptation in many places. These approaches pose interesting challenges, in particular in connection with top-down versus bottom-up paradigms. Furthermore, and despite i) the actual risk of collective disaster, ii) the scientific consensus that anthropogenic greenhouse gas (GHG) emissions perturb global climate patterns with negative consequences for many societal and ecosystems and iii) the predictions of early warning signals and severe climate change consequences that are already in place, such as increased occurrence of heat waves and droughts, country leaders insist in discounting the severity of the problem, given the scientific uncertainty regarding the impacts of climate change, which only makes it more urgent to solve the Climate Change problem.

In this presentation, I will demonstrate what science already has identified as plausible outcome of the ongoing and likely future anthropogenic interference with the climate system. The role of high end scenarios, such as the recent RCP8.5 and older A2 in framing how the world will look entirely different will be discussed. By focusing on very warm futures that by many are considered as of low probability, the call for solutions will become even more obvious – can we actually rule out a climate of Copenhagen in 2100 will look like today in Bordeaux?

Extreme weather events, high impacts and perceptions of change

Grete Hovelsrud; Nordlandsforskning - Nordland Research Institute, Bodø, Norway

The frequency of extreme weather events are expected to increase and we can already observe high impact events as evidence that this is taking place. The impact of such events depends on where you are, who you are and the resources available to handle the consequences. There is a difference in national and local perceptions of the cause of such events and the linkages to anthropogenic climate change. This key note will explore the gap between the plethora of scientific evidence on climate change and how such knowledge is perceived and acted upon at the local level.

Quantifying the human contributions to observed changes in precipitation extremes

Francis Zwiers; Director, Pacific Climate Impacts Consortium, University of Victoria

The body of evidence indicating a human contribution to observed climate change had continued to strengthen over the course of the 5th assessment cycle of the Intergovernmental Panel on Climate Change (IPCC). This continued development includes an accumulating body of evidence suggesting that on global scales, temperature and precipitation extremes have both changed in response to human influences on the climate over the past half-century or so. The research on temperature extremes, in particular, is now quite well established, although work to understand the feedback mechanisms involved in individual extreme temperature events is ongoing. The evidence on precipitation extremes is less well established, although there is increasingly strong evidence that human influence is detectable in observations at the largest scales that are resolvable in available international compilations of daily precipitation records. Increasingly, climatologists are using statistical extreme value theory in their analyses, although most studies to date have not explicitly modelled the spatial dependence of extremes. This talk will review some of the recent detection and attribution research on historical changes in precipitation extremes and projections for the future. It will also point out some statistical challenges that arise from this work.

Wednesday session – IPCC AR5; so what now?

Decisions and strategies in forestry related to weather extremes and climate change

Fredrik Lagergren; Lund University
Anna Maria Jönsson; Lund University

Managed forests should give the owner a reasonable income and also supply other values such as biodiversity, recreation and mitigate climate change. The future is important when planning for sustainable forestry, and decisions should be taken strategically with an insight into long-term impact on the utilities and goals. Today, there is a multi-use of forest with socio-economic, health, climate change and energy supply aspects. Forestry decision support, therefore, has to be more complex, requiring the development of different techniques for analyzing different options with respect to a multitude of management goals and risk taking strategies at different levels. In addition, the climate-related information contains many unknowns, and there is need of developing knowledge on how to handle uncertainties. Climate change will affect risks but also possibilities in the forestry. Examples of plausible impacts are an increase in productivity, occurrence of new pests and pathogens, and loss of biodiversity. There can also be more frequent extreme weather events, which will increase the risk of damage to production forests and have negative impact on biodiversity. It may be possible to actively manage an increase in risk by adaptive selection of tree species and provenances when regenerating, intensity of thinning and length of rotation period. The active strategies for climate adaptation have to be complemented by a readiness for reactive measures if damage occurs (e.g. sanitary cutting of insect infested tree). The forest owners can also draw up a proactive risk strategy for preserving future options and spreading risks by diversification. In combination with climate and weather, the outcome depends on a long list of forest management decisions. Among the most important are selection of tree species during regeneration and the timing of thinnings and final harvest, as these have a direct effect on the growth of trees and the risk of damage. We will present an approach to systemize and evaluate decisions in forestry with a perspective of goals, climate change and risk management. The species selection, e.g. will affect economic, biodiversity related, recreational and carbon mitigation goals on a 60-100 year time perspective, partly depending on uncertain future variables such as climate, weather extremes and economical demand. If a forest owner would know exactly what the future will look like and all consequences it will bring, adaptation of the forest management, e.g. for minimizing the risks, would be an easy task. In reality this is not possible, but information about the probability for a certain change is enough for making active adaptive decisions. In order to adapt forest management to climate change, it is necessary to work with active as well as reactive and proactive strategies.

Jönsson, A.M., Lagergren, F. and Smith, B. 2013: Forest management facing climate change - an ecosystem model analysis of adaptation strategies. Mit. Adapt. Strat. Glob. Change. DOI: 10.1007/s11027-013-9487-6.
Lagergren, F., Jönsson A.M., 2014. Klimat, beslut och strategier i skogsbruket. In: Rummukainen, M. (ed.) Mistra-SWECIA årsrapport 2013, pp 12-13.

Modelling framework of simulating every day storm water sewers and cloudburst green area runoff

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Traditionally, Danish sewer systems are designed to hold storm water up to a 5 or 10 year return period. Anticipating the changing climate, a climate factor has been applied for inclusion of future higher rain-intensities. Furthermore, experiences from recent cloudbursts together with climate projections of more intense and frequent cloudbursts, has started an adaptation movement towards including cloudburst-protection within the planning of the urban drainage system. In Denmark, today, the sewer companies are responsible for handling storm water up to a future (100 year) rain event of a 5-10 year frequency. For cloudbursts above this, the municipalities may have an emergency plan. This division of responsibility also divides planning of extreme precipitation. Traditional sewer models only include runoff from impervious areas, and does not account for green areas runoff. In climate adaptation of urban drainage systems, the whole system is rethought and planned together; for every day rain and cloudbursts alike. Green area runoff to local surface depressions and the sewers may potentially be large, when the rain intensity exceeds the infiltration capacity. Therefore, green areas cannot be neglected when doing cloudburst-planning. At present there are no national guidelines of how to include green area run-off into drainage models. This presentation presents a modelling framework that incorporates the divisions of responsibilities. Furthermore, it directs accuracy and computer resources to where it is most useful. The model is set up to meet the demands of the water company Aarhus Water (Second largest water company in Denmark). The model must be able to: 1) Simulate present day sewer systems up to storm water of 10 years return time. 2) Simulate scenarios of implementation of SUDS (Sustainable Urban Drainage Systems), both the full implementation and different implementation steps. 3) The level of detail has to be at single houses and gardens; for including private soakaways, infiltration beds (rain-gardens) or canals. 4) Simulate and dimension plan terrain modification for handling cloudburst. 5) Include runoff from green areas. 6) Simulate flows in sewage system and on terrain in a 100 year cloudburst event. For all impervious surfaces, roofs and roads, the setup uses a time-area runoff calculation based on wells in the sewer system. The sewer system is modelled as 1D pipeflow in Mike Urban. All plan solutions of SUDS, e.g. soakaways, infiltration beds or canals is included in Mike Urban. The sewer system is coupled to a 2D model for simulating overland flow, Mike 21. This combination is also known as Mike Flood. All terrain modifications of handling cloudburst water, e.g. changing profiles of roads and remodelling of planned flood areas, are included in the surface model. In regards to green areas, which under normal rain events do not contribute to the drainage system, the estimate runoff is added to the terrain model and flow according to the terrain. Estimation of runoff is based on Green and Ampt (1911). Using the model framework, the model only needs the 1D pipe-flow part for simulation of every day rainfalls up to the dimensional criteria of 10 year events. In this way, the model is computational quick and many different solutions or dimensions can be tested fast. It can also be used for long term simulations e.g. 30 years. In principle, only when dealing with cloudbursts, the model needs the terrain model. Modelling 2D terrain flow is much more computational demanding then 1D pipeflow, and therefore it is a major advantage, that the model does not need to take that into consideration for every day rainfall calculations. Furthermore, this framework presents a methodology of including green area runoff.

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Climate change adaptation in the railway sector: an International Comparison

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This paper reports on how climate change is perceived and approached through adaptation strategies by companies of the railway sector in Europe. The work is part of the EU project ToPDAd (www.topdad.eu) that investigates the impact of climate change on the transport, tourism and energy sectors. The work presented is part of a project aimed at developing adaptation strategies that stakeholders - policy makers or private firms - could implement to limit climate change negative effects. This includes the development of a specifically designed toolset which will assist them adapting the strategies to their individual needs.To identify particular sector needs related to climate change adaptation a series of face-to-face interviews with key stakeholderswere conducted. The work presented here considers only companies of the railway sector and consists of an analysis of these interviews. A total number of 10 interviews of companies based in Switzerland, UK, France, Spain, Netherlnads and Finland were collected. Two main aspects appear to affect the vulnerability of railways to climate change. The first is the degree of exposure to potentially damaging weather conditions now and in the future. The second is the average lifetime of assets (infrastructure, trains). The average lifetime of a railway car is 40 years, the average lifetime of the tracks is 100 years and can be even longer for bridges. This means that the infrastructure that is built and planned now will experience the conditions of 2050 and beyond. The change in climate conditions in this span of time in a specific area is what matters to the companies. Climate change is predicted to have a broad range of impacts that can be substantially different from region to region. Not surprisingly, preliminary analyses of the interviews show that the priorities very specific of the area where the companies are operating. The Swiss national railway company emphasizes general resilience to climate change over adaptation to specific threats because of the large land type and land use over Switzerland?s small area. In contrast, smaller, regional companies put already today strong emphasis on their ability to deal with extreme weather events. In Finland and the UK railways located very close to the sea are one of the main issues because of expected rising sea level. A Scandinavian specific issue is the maintenance of railway basements. They are under much more stress if more rainy weather combines with more thaw-frost cycles in autumn as expected in the future. The interviews presented give insights which are potentially useful for policy makers, scientists and for the stakeholders themselves. For policy makers, they provide a qualitative feedback on already implemented policies and can inspire new policies. Scientists, similarly, get hints on what topics are more relevant for stakeholders and on the adaptation strategies they are implementing to cope with it. This is a suitable basis to evaluate current strategies and explore new ones. Stakeholders can profit from additional knowledge on current practice within their sector, and learn from the experiences of other companies encouraging a deeper reflection on their current approach.

Environmental multi hazards from increased precipitation in coastal urban areas - Knowledge for adapting without causing second consequences

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Frogner-Kockum; Swedish Geotechnical Institute
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Larson Magnus; Lund University of Technology
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When society adapt to climate change and planning for growth, more attention must be given to land use and the use of materials so that adaptation can be done without impairing water quality and the ecosystem we are so dependent on. Many urbanised areas are located in the vicinity of surface waters and many of these areas envision (economic) growth which in most cases means more people, more buildings, more industries, more infrastructures, i.e. an increased pollution load to the environment. Thus, for a sustainable growth for future, climate change effects must also be considered with regard to the management of hazardous substances and in the light of low-probability but high-magnitude events, so that there can be room for urban development without degrading the quality of the ecosystem services in our waters. A study of the Gothenburg area, SW coast of Sweden, show that there has been a large increase of both precipitation and groundwater level but also the discharge since 1961, particularly during the last 20 years. The data presented in the study shows on a relation between a short term increase in precipitation (wet weather period) and an increase in pollutant concentration and transportation in three rivers that runs through the urban area. Data also indicates that wet periods bring more particles and contaminants to the rivers through increased runoffs and groundwater flows. Elevated concentrations could thus be linked to higher groundwater levels that will mobilise pollutants from urban surfaces (including air borne deposition and the weathering of materials) and urban soils. In addition, a levelled groundwater table and increased erosion from extreme events will have negative impact on bank erosion, slope failure and, in a worst case, landslide. The spreading of contaminants from bank erosion occurs already today and there are indications that several of the contaminated sites along the Göta Älv river (Gothenburg area) also are exposed for a landslide risk. If such an event occurs, high concentrations of contaminated soil may end up in surface waters, and further spreading of pollutants by the river water may cause short term acute toxic levels in the surface waters and will contribute to a significant increase in the pollution load to the coast. This was investigated in a unique study on two hazards that are interconnected but not until now have been analyzed simultaneously, namely landslides and contaminated soils. By combining results from different types of risk assessments and superimposing the results, possible multi hazards may be revealed, which is not the case when the results are only displayed independently. Increased rainfalls, levelled groundwater table and increased river flows affect sediment and soil properties with impact on the spreading of pollutants from urban soils and surfaces and through bank failure of contaminated land adjacent to rivers. By combining results from different types of risk assessments and superimposing the results, possible multi hazards may be revealed. Cross- sectorial communication and interdisciplinary sciences are thus significant key stones to even be able to see and understand all the dimensions of what climate change will bring with regard to the environment and so that adaptation is done without creating second consequences that we could not foresee.

Göransson, et al. (2013). Sci Tot Env 472: 481-495. Göransson, et al. (2009). J Soil Sediments 9: 33-45. Haeger-Eugensson, et al. (submitted). Impact from precipitation on micropollutants in urban waters, and possible future regional climate change effects.

Vulnerability of cross-country skiing to climate change in Finland - Interactive mapping tool

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Temperature and snow depth scenarios for Finland project decreased future skiing opportunities, which could result in a decline of participation in skiing. We present a user-based mapping tool for exploring future climate change impacts on winter recreation, combining exposure indicators with indicators of potential adaptive responses based on survey information. Cross-country skiing is an important leisure activity in Finland and part of cultural heritage. Over 40 percent of Finns report to have participated in cross-country skiing during recent years and 10 percent of nature-based tourism trips are done for skiing. Traditional skiing uses extensive land areas with natural snow cover and cannot easily rely on artificial snow. Skiing facilities, such as lit and maintained ski tracks, are one of the most important recreation services municipalities provide. Snow depth estimates, under scenarios of future climate, project decreases in skiing opportunities over much of Finland. Opportunities in southern Finland and coastal regions are expected to be especially severely affected. This will affect participation in cross-country skiing, which could result in a decline of the annual number of skiing occasions for those who participate in skiing. The vulnerability of participation in cross-country skiing to climate change can be defined as a function of exposure to climate changes affecting the skiing conditions, sensitivity to this exposure (expressed in terms of participation) and adaptive capacity to respond to the changed conditions. To represent exposure, we used estimates of changes in snow depth simulated with a hydrological model under a range of climate scenarios and aggregated on a municipal-scale (Veijalainen, 2012). Adaptive capacity was represented using indicators based on a survey monitoring outdoor recreation at regional-scale in Finland (Sievänen & Neuvonen, 2011). This covered skiers technical adaptation (e.g. skiers willingness to adapt new techniques), locational adaption (e.g. skier willingness to travel or change skiing area), and activity level of adaptation (e.g. give up on skiing) if future conditions deteriorate. An internet-based interactive mapping tool was developed for visualizing these indicators and combining them into user-selected indices of vulnerability. The tool integrates physically-based information on skiing conditions with survey data about potential winter recreation habits. The tool provides information relevant for stakeholders like national planners and decision-makers as well as the general public, to assist in planning and developing skiing services. Initial mapping exercises provide persuasive evidence that skiers in Southern and Western Finland are more vulnerable to climate change than those living in Eastern and Northern Finland. The study was part of the project ?Map- based assessment of vulnerability to climate change employing regional indicators? (MAVERIC), funded by the Academy of Finland. The User-based Climate change Impacts, Adaptation and Vulnerability mapping tool (U-C- IAV) is available online at http://www.iav-mapping.net/U-C- IAV/skiing/

Sievänen, T., Neuvonen, M. (Eds.). 2011. Luonnon virkistyskäyttö 2010. [Outdoor recreation 2010]. Working papers of the Finnish Forest Research Institute, 212. p. 190. Veijalainen, N. 2012. Estimation of climate change impacts on hydrology and floods in Finland. Aalto University publication series DOCTORAL DISSERTATIONS, 55, pp. 211.

Wednesday session - Mainstreaming

Government framings of climate change adaptation in three countries: steering insurance sector approaches

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The room for insurance companies and organizations to maneuver in approaching adaptation is influenced by national adaptation policy framing in general and by government involvement in the construction of natural hazard insurance in particular. In this study the connection between national adaptation policy and non-life insurer's adaptive behaviors are explored in three case countries, Denmark, Norway and Sweden. The insurance sector has an important role in facilitating climate change adaptation due to their cost distribution and influence on the risk mitigating behavior of insurance takers. However, the room for insurance companies and organizations to maneuver in approaching adaptation is influenced by national adaptation policy framing in general and by government involvement in the construction of natural hazard insurance in particular. As shown in previous research are adaptation an issue which often has followed a logic of path-dependency in how its nationally framed which have affected management in lower levels of public and private policy and management (Juhola et al. 2011, Mees et al. 2012, Glaas 2013). In this study the connection between national adaptation policy and non-life insurer's adaptive behaviors are explored in three case countries, Denmark, Norway and Sweden. The three countries have somewhat similar insurance structures but the national governments have approached adaptation differently. Document analyses have been used to identify national framings of adaptation while qualitative interviews with insurance company and organization representatives were used to map insurer's approaches and attitudes to adaptation. Results shows that national top-down approaches to adaptation as in Denmark and partially in Norway has facilitated an active involvement of the insurance sector in identifying climate risks and adaptation measures which has helped to clarify the situation for insurance takers. State led risk pooling as used foremost in Norway has contributed to a minimization of economic risk, however, for insurance companies at the expense of insurance takers, and have also led to a decreased incentive for insurance companies to approach adaptation. These findings illuminate the need for national governments to involve insurance sector representatives in analyzing climate risk and adaptation measures, whilst avoiding to impact incentive structures in natural hazard insurance at the risk of being contra- productive.

Glaas, E. 2013. Reconstructing Noah's ark: Integration of climate change adaptation into Swedish public policy. Linköping Studies in Arts and Science No. 578, academic doctor dissertation, Linköping University, Linköping Juhola, S., Keskitalo, E.C.H. and Westerhoff, L. 2011. Understanding the framings of climate change adaptation across multiple scales of governance in Europe. Environmental Politics, 20(4): 445-463. Mees, H.L.P., Driessen, P.P.J. and Runhaar, H.A.C. 2012. Exploring the scope of public and private responsibilities for climate adaptation. Journal of Environmental Policy and Planning, 14(3): 305-330.

Climate-related risk drivers and the private sector

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Markus Groth; Climate Service Center (CSC)

The private sector has been increasingly concerned with current and future climate change risks that have the potential to generate a substantive change in their business operations, revenue and/or expenditure. For this reason the study tries to create a higher awareness of risk drivers specific sectors have to deal with. Further it provides private sectors with new ideas to adapt to climate change risks by taking best practices in regard to specific risk drivers from different sectors into consideration. The study looks at the risk drivers companies in the DACH region have to deal with, comprising changes in regulation, changes in physical climate parameters and changes in other climate-related developments. It is based on the CDP (Carbon Disclosure Project) Data from 2013, including Data from 125 companies from the following sectors: Consumer Discretionary, Consumer Staples, Energy and Utilities, Financials, Healthcare, Industrials, Information Technology, Materials, and Telecommunication Services. CDP has incentivized thousands of companies and cities across the world?s largest economies to measure and disclose their environmental information, which provides a database from the private sectors perspective. In comparison to past studies (CDP 2013) on potential impacts of climate-related risk drivers on the private sector, which focused specific sectors, this study provides a new perspective on dealing with the threat caused by climate-related risk drivers. The project does not only look at the risk drivers which have been named most often by companies, but additionally measures the actual threat of these specific risk drivers and by this simultaneously tries to minimize distortion of results. The actual threat can take on different forms, such as increasing operational cost, increasing capital cost, a reduced demand for goods/services and/or the inability to do business. The potential impact representing the actual threat to the private sector is measured by the simultaneous consideration of the magnitude of impact and the likelihood of occurrence for every single risk driver. By this it is possible to avoid distortion of results with regard to overestimation of above average frequently named risk drivers with low likelihoods and/or low magnitudes of impact and underestimation of below average frequently named risk drivers with high likelihoods and/or high magnitudes of impact. The results of the study facilitate a comparison of risk drivers between and within sectors. Further, the results can be grouped according to sectors facing specific risks with a similar degree of consequences. This enables companies to adapt to climate change risks by evaluating the specific risks they are facing and by taking best practices in regard to specific risk drivers from different sectors into consideration.

CDP 2013: Sector insights: what is driving climate change action in the world´s largest companies? Global 500 Climate Change Summary Report 2013. PricewaterhouseCoopers. London. United Kingdom.

A changing climate for business

Maria Larsson; INDEA AB
Karl-Erik Grevendahl; Grevendahl Development AB

Companies should seek to be as resilient as possible to avoid production interruption caused by climate change. Risks should be managed and opportunities should be seized. The scope of the project A changing climate for business is to find methods for the companies to work systemtically with resiliens to climate change. How will climate change affect the economy of Swedish companies? Are there factors for success at the companies that will be strengthened by climate change, and are there those that will be weakened? How can climate change be put into the companies? business development in a structured way? Those are questions to be investigated in the project A changing climate for business. Climate change should be incorporated into the businesses development. Risks should be managed and opportunities should be seized, just like other external factors to take into account. Companies should seek to be as resilient as possible to avoid production interruption, to be more of a winner than a looser according to climate change. The scope of the project is to develop a method to help companies to be resilient in a changed climate. It will take into account direct and indirect, positive and negative economical consequences of climate change for business in Sweden. The method is applied on specific companies connected to forestry and food production in the region of Scania. The project is managed together with 8 companies in the value chains of food and wood. The companies involved are: ? Findus ? Hässleholm Miljö ? KC Ranch ? Lyckeby Starch ? L&M Malshult Handelsbolag ? På fatet ? Salix Energi Europa ? Scandinavian Aquasystems The companies are supported in recognizing their factors for success and identifying what kind of risks and opportunities climate change will put upon them. As far as possible identified risks are calculated to get a hold of the amount of economic impact they could result in. The companies are also supported in what kind of actions and decisions that could make their business plan more climate adapted. The project focus on six different aspects: ? Premises ? Process ? Logistics ? Markets ? Product development ? Finance, insurance and legislation The project is financed by: ? The County Administrative Board of Skåne ? Environmental fund of Skåne Regional Council ? Utvecklingsstiftelse Sparbanken 1826 ? Swedish Board of Agriculture ? Tyréns AB The project co-operates with the science programme Mistra-SWECIA, with scientist from University of Lund and Stockholm Environment Institute. Findings so far: - Start with a resilient perspective - what in climate change will reduce or inhance business continuity? - Before talking about what could happen, start with what has already happened. - Talking about opportunities engage more than talking about risks. Opportunities can be a door opener for talking about risks. - Get the companies to look at their value chains, from raw materials to customers. Try to find ways of cooperation. - Connect to the companies risk management. - Concider both direct and indirect consequences.

Adaptation Scotland. Climate risk management plan - Towards a resilient business www.climatenortheast.com Environment Agency (2013). Assessing and managing climate change risk in supply chains. IMEA. Climate change adaptation. Building the Business Case. UKCIP (2009). A changing climate for business - business planning for the impacts of climate change.

The role of insurers in mainstreaming climate-related actions

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Climate change is already having, and will continue to have, a substantially negative impact on society. Therefore, it is imperative to enlist those critical actors who can take part in mainstreaming climate-related actions, both mitigation and adaptation. The primary insurance industry?s role in managing climate change risks and opportunities has already been recognized, as well as the role of non- life insurers in helping authorities in fulfilling climate commitments (Ahvenharju, Gilbert, Illman, Lunabba, & Vehviläinen, 2011; Dlugolecki, 2008; Jóhannsdóttir, Wallace, & Jones, 2012; Maynard, 2008). By now, it is well established that insurers are in a position to effect greater changes in this regard (The Geneva Association, 2009; Vellinga, et al., 2001; Wilbanks, et al., 2007), than they actually are doing (Johannsdottir, et al., 2013; Mills, 2007). The paper is based on doctoral research by the author who will discuss the structure and the integration of insurance companies in societies and how the structure and product offering can be used as an enabling factor for mainstreaming climate-related actions. The starting point is to discuss key stakeholders of insurers, including individuals, corporate clients, suppliers, partners, authorities, and re-insurers. Insurers? product lines are also of importance, as are investments and claims handing. Through the core business, insurers are in a position to influence the actions of various stakeholders, both their clients as well as authorities. A part of mainstreaming climate- related actions is to understand the idiosyncratic circumstances of relevant actors, and how they can be used to achieve positive changes, both through technological solutions as well as through behavioral changes.

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Wednesday session – Limits and oppertunities

Adaptation governance at the sub-national level

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The regional level - understood as the sub-national level of governance - has been given a prime role in adaptation governance in Norway and other European countries. Our case study on regional adaptation governance in Norway finds that the potential for regional mainstreaming of adaptation unfulfilled in particular when it comes to its importance as a boundary organisation" translating scientific climate change knowledge into policy." As there is increasingly evident that society will have to face the consequence of climate change, the local level of government have been deemed a key agent of adaptation. This points to the role of municipalities as the principal spatial planner in the Nordic countries. However, the capacity and competence of municipalities to carry out planning where adaptation to climate change is implemented varies significantly (Dannevig et al. 2013). The approaches to adaptation varies between municipalities, and in general it is less prioritized than other policy field because it is not viewed as 'political', lack attention from the public and have to compete with other, more pressing issues (Dannevig et al. 2013) . The Norwegian green paper on adaptation raised the call for stronger support for the municipalities in both carrying out vulnerability assessments and development of adaptation strategies, and the various branches that constitute the regional level of governance has been deemed the appropriate level for this task (Termeer et al. 2011). This paper investigates the sub-national, regional, levels role in implementing adaptation at the local level through a case study consisting of the regional authorities in four counties that constitute Western Norway. These authorities includes the elected county council, the county governor (that represent the national government) and the agency in charge of mitigating natural hazards, the Norwegian Water and Electricity directorate (NVE). In addition we have carried out an in-dept study in one to three municipalities in each county in order to get a bottom up understanding of the experienced impact of the regional adaptation governance. The county councils are investing much efforts in developing comprehensive plans on both energy, climate change mitigation and climate change adaptation, which have a potential for bridging scientific climate change knowledge to policy. But little knowledge exist on the regional authorities ability to implement and mainstream adaptation at lower level, and which policy instruments and mode of coordination that is applied in this work. In general the role of the regional authorities in unitary states for the case of environmental policy-making has been strongly underfocused (Termeer et al. 2011). Applying a multi-level governance perspective, the paper analyses the regional authorities ability to coordinate and mainstream municipal adaptation through spatial planning and knowledge provision, in addition to identify the means of coordination and policy instruments being used Despite it's potential role as a ?boundary organization?, we find that the county councils climate plans have a limited impact on municipal adaptation. Due to its role as the overseer of municipal governance, the county governor currently is the regional governance actor with the largest impact on municipal adaptation, because they posses the policy instruments that allows for more efficient implementation and mainstreaming of adaptation. Our study also shows that the county governors interpret national guidelines and regulations for adaptation in different ways, which again are reflected in differentiated municipal adaptation planning across the counties.

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What is worst: bad planning or bad weather?

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Halvor Dannevig; Western Norway Research Institute
Kyrre Groven; Western Norway Research Institute
Ragnar Brevik; Western Norway Research Institute

A study of recent weather related natural hazard events (WNH) in Norway has increased the knowledge on the problems and prospects of adapting to climate change by means of local spatial planning. Adapting society to challenges posed by WNH has always been a central issue of spatial planning, and occasionally society will experience severe damage from such events no matter how much effort is put into spatial planning. The history of spatial planning as a policy means for local adaptation to climate change is however relatively short and research on constrains experienced by local authorities in this respect has revealed rather simplistic factors such as limited resources, lack of relevant competence and lack of information (Measham et al, 2011). In this paper we will pursue the points made by Measham et al (2011) that this focus has obscured a wider set of constraints which need to be acknowledged and addressed if adaptation is likely to advance through municipal planning. Thus we will lean on insights from previous research on local environmental planning (e.g. Næss, 1994; Næss and Sagli, 2000) and use these insights to analyse experiences from recent WNHs in order to shed light on the problems and prospects of adapting to climate change by means of spatial planning. In 2012 the project ?Spatial planning and preparedness for a changing climate? was initiated including a study of 10 recent WNHs taking place in Western Norway. In these analyses we wanted to find out whether the damage could have been less severe if the spatial planning process had been carried out differently. Our analyses revealed that 7-9 of the events could be framed as part of the current climatic regime. In 80-90 % of these events, the observed damages could have been avoided if planning had been conducted according to current laws and standards on ?good planning practice?. In 90 % of these cases the danger of natural hazard events were not even assessed, and in 70% of the cases buildings were built without a zoning plan in place. A number of reasons and mechanisms to explain these flaws have been identified. 1-3 of the events could be framed as examples of the expected future climate regime. In these examples current laws and standards on ?good planning practice? proved to be insufficient to avoid damage. In all of the cases belonging to this category, the natural hazard event that took place was water saturated mud slides linked with extreme precipitation. The paper concludes by discussing the nature of what we define as the double trouble of the climate risk society; that is a society that continues to produce unsustainable levels of greenhouse gas emissions and at the same time makes itself increasingly vulnerable to WNHs. Analysis of recent WNHs in Western Norway reveal that there is a large untapped potential in conducting ?good planning? in order to reduce negative effects of such events. Thus, a crucial first thing to do when preparing for worse weather to come due to climate change is to improve adaption to current climate variability.

Measham, T.G., Preston, B.L., Smith, T.F., Brooke, C., Gorddard, R., Withycombe, G. Morrison, C. (2011): Adapting to climate change through local municipal planning: barriers and challenges, Mitigation and Adaptation Strategies for Global Change, Volume 16, Issue 8, pp 889-909, DOI 10.1007/s11027-011-9301-2. Næss, P. (1994): Normative planning theory and sustainable development, Scandinavian Housing and Planning Research, Volume 11, Issue 3: 145-167. Næss, P., Saglie, I-L. (2000): Surviving Between the Trenches: Planning Research, Methodology and Theory of Science, European Planning Studies, Volume 8, Issue 6: 729-750.

Extracting causal linkages from a federated database of case studies

Patrick Arthur Driscoll; Aalborg University-Copenhagen
Martin Lehmann; Aalborg University
David C. Major; Columbia University

There is a large body of single and small-N case studies investigating urban climate adaptation around the world. This paper describes some specific methodologies, such as fuzzy set QCA and process tracing, that may be used to tease out scientifically sound causal mechanisms that underpin adaptation planning at the urban scale around the world. This presentation examines challenges associated with the development of a scientifically robust, logically sound, and methodologically rigorous research framework in connection with the research and writing of the Second Assessment Report on Climate Change and Cities (ARC3-2). The research underway deals with: what types of propositions/prior knowledge should be deployed; how case studies can be developed in a consistent manner. How previously developed cases with radically different data collection and analysis protocols can be compared. What sort of tools are necessary to be able to extract the relevant data points and findings from individual case studies. And what types of mixed-methods research are relevant. The work is led by European researchers in connection with contributors from other continents. The need for dealing with these issues is evident. For example, within the field of climate change planning at the urban scale, there is an ever-growing body of single and comparative case studies and extractable databases investigating a variety of phenomena related to both mitigation and adaptation planning and policy (Kazmierczak, A., & Carter, J., 2010). Case studies are often a good research method when investigating empirically rich and localized contexts (Yin, 2009; Flyvbjerg, 2006), but the case study method can be less than ideal when there is a need to understand complex causal mechanisms across a range of spatial and temporal scales. Most of the databases that exist today share many of the same faults, in that they neither allow for federation/aggregation of disparate data sets nor do they facilitate more complex queries that could reveal common causal mechanisms or structures that underpin the observed data. Thereby, unfortunately, the knowledge created in the multitude of case studies or available from databases are of limited direct use in informing practice for planning and/or policy making purposes. The study reported on here, in its initial stages, aims at repairing some of these deficiencies, and it is hoped that this presentation will stimulate further development of robust methods of cross- case comparisons of urban climate change strategies. There are three main findings from this research. First, our review of existing literature has uncovered relatively few publications that have conducted either systematic investigations or meta-analyses of prior studies within the intersecting fields of urban planning and climate change. Second, the research community could benefit from a more critical focus upon a common framework of understanding about what are the independent and dependent variables within climate change planning. Finally, fuzzy set Qualitative Comparative Assessment (QCA) is a well-established methodology within comparative political studies and has significant potential to be applied within the field of urban climate change planning.

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Optimal Decision Making, Adaptation to Climate Change in the Agricultural Sector.

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The aim of this paper is to develop a framework applying Bayesian update of belief to use for modelling the decision of adaptive behaviour of farmers to climate change. Subjective beliefs of the likelihood are taken as a starting point, and then we show how these beliefs can be updated based on observed changes. The Bayesian framework developed allows modelling the complexity of climate changes. The main focus of this paper is on the framework developing and aims to show the advantage of a proactive adaptation to climate change, instead of reactive. The observed changes used for updating the beliefs are here simulated climate scenarios development over time. The Bayesian framework developed applies a hypothetical decision-making problem of the choice of three agricultural systems (paddy cultivation (traditional), integrated farming (new) and livestock production) under a trajectory of three climate scenarios. The Coastal Adaptation and Resilience Planning Program, in Cambodia have kindly shared information about the agricultural systems used in the Prey Nob commune, Prey Nob Districts, Cambodia. Exploratory interviews with farmers have also been conducted in the Prey Nob commune, Cambodia. In conclusion, the Bayesian framework works as intended, and give the farmer indications on what the optimal agriculture systems would be under different climate scenarios.

Bayes, T. and M. Price (1763) An Essay towards Solving a Problem in the Doctrine of Chances. Philosophical Transactions of the Royal Society of London (53) pp. 370-418 Yosefpour, R., J. B. Jacobsen, H. Meilby, B. J. Thorsen (2013) A Bayesian Modelling and simulation Concept for Knowledge Update in Adaptive Management of Forest Resource under Climate Change, In review with Annals of Forest Science.

Smart pre-breeding of barley for a future climate with concurrent hazards

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Climate is changing and challenging crop production. Our experimental results indicate a 30 % decrease in overall grain yield and maintained vegetative aboveground biomass production of 138 spring barley accessions cultivated in a climate phytotron under future climate conditions of elevated temperature and carbon dioxide ([CO2]) combined. The results also revealed considerable differences between the individual accessions to be exploited in plant breeding. To secure the future production, accessions producing stable and high grain yields must be identified for use in breeding programs. Here we have associated yield parameters under future climate conditions with DNA markers. DNA markers can facilitate a more precise and faster breeding process towards climate resilient cultivars. In the present experiment 138 spring barley accessions were exposed to scenarios mimicking potential future climate in South Scandinavia. The treatments were a +5°C temperature increase (24/17°C day/night), an elevated [CO2] concentration at 700 ppm, and elevated ozone at 100-150 ppb in single or two factor treatments. All treatments and plants received the same amount of water. The production parameters grain weight, aboveground vegetative biomass, total number of ears and ears with grain were obtained on single plant basis, and grain number as well as harvest index was calculated. To investigate climate resilience, the stability indices, ?Wricke?s ecovalence? and ?environmental variance? were calculated for each agronomic trait over all treatments. For genome-wide association analysis DNA from the barley accessions was applied on an array of 7864 SNP markers (ILLUMINA). Genome-wide association analysis (GWAS) was performed on identified agronomic traits under the climate scenarios. After strict validation to exclude false positives 44 annotated SNP markers were found to associate with different traits. Two separate areas on the barley chromosomes were found associated with grain yield under elevated [CO2]; the markers localized here can have potential for breeding cultivars with high grain yield under the predicted higher [CO2]. Three markers associated with favorable traits in the two-factor treatment, where both temperature and [CO2] were elevated. Two of these associations were not found in the corresponding single factor treatments of temperature and [CO2]. This finding suggests that mechanisms involved in resilience towards either of the single factors are not the same as those in the combined treatment. Seven markers associated with one of the climate resilience indices for grain weight indicating a potential for using DNA markers for selecting towards cultivars with a stable grain yield in a number of different environments. Stable and high yielding cultivars are essential to secure production under future climate conditions. Despite the challenges in establishment of markers for quantitative traits, our findings with identification of markers associated with stability and grain yield, suggest that GWAS is a valuable tool, when breeding for fitness in variable environments. Further, presented results emphasize the need for evaluation of crop accessions under experiments with more climate factors combined in order to make realistic predictions.

Special session: Managing climate change in Nordic cities – challenges of implementation

Climate Change Adaptation in Copenhagen - from plan to implementation

Lykke Leonardsen; City of Copenhagen
Jan Rasmussen; City of Copenhagen

The presentation will focus on the process of the adaptation plan for Copenhagen, and will present the main contents of the plan ? and the process of making the plan ready for implementation, including financing, integrating adaptation in urban development and the existing infrastructure. The Copenhagen adaptation plan was approved in 2011. The plan describes the impact of future climate change on the city and sets the strategy for adapation. Since then the city has been working on mainly the Cloudburst Management Plan that was produced in 2012 following a massive cloudburst in 2011. The plan divides the city into 7 water catchment areas, and sets the level of future protection for the city. In 2013 detailed plans for all 7 catchment areas were produced and they have all been politically approved in 2013-14. The city is currently preparing how to implement this wast construction work over the next 20-30 years. The work on the implementation plan involves detailed studies of the financing structures, the socio-economic aspects of adaptation, integration of measures into existing urban structures, development projects and infrastructure. The adaptation plan will be carried out in a partnership with the Copenhagen Water Utility Company. So an important aspect of the plan is to describe and agree on an organisational structure that will ensure the coordination of the water utility company?s work with the work of the city and allocates the ressources that will be necessary to implement the plan. Another important aspect of the implementation plan will be to look for synergies with other city strategies and initiatives in order to reduce both the costs and the amount of construction work needed in order to implement the plan. Finally another important issue is the environmental issue where the high political demand for environmental attention on water quality is a challenge that has to be adressed as part of the implementation plan. One of the key foci for the city has been the opportunities that adaptation is als creating for the city. The Cloudburst management plan and the plans for the 7 catchment areas focus on the added qualities that adaptation can bring to the city with a more intensive greening, the use of adaptation constructions for recreational purposes. With the implementation plan the city of Copenhagen will be one of the first cities in Europe ?if not the world to start implementing a full scale adaptation plan. The presentation will present both the climate change adaptation plan of Copenhagen ? with special focus on extreme rain events ? and describe the process towards the implementation plan, and of course also the contents of the implementation plan. Conclusions and findings: The conclusions of the presentation will be the illustration of the complexity - but also of the co-benefits and the opportunities that a city can have from an integrated approach to adaptation. But also to demonstrate the setup of the implementation.

Climate Change Adaptation Plan, 2011 Cloud burst Management Plan, 2012

Balancing between mitigation and adaptation in the City of Helsinki

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Haapala, Auni; City of Helsinki Environment Centre

This abstract is presenting some of the challenges the City of Helsinki is facing in the implementation of climate work while balancing between mitigation and adaptation goals. Previously the focus of the climate work in Helsinki has been mainly on mitigation. The goals of mitigation are ambitious and more resources are allocated to the mitigation work than to adaptation measures. Now the slowly growing attention to adaptation has brought up the possible synergies and trade-offs between mitigation and adaptation. Despite the lack of separate city climate strategy Helsinki has been promoting ambitious climate change mitigation efforts for over a decade. Currently the city is aiming for 30% reduction in GHG emissions (1990- 2020) and carbon neutral Helsinki by 2050. The city?s adaptation goals are: the integration of adaptation to the city processes, improving the flood and storm water management and preparedness to extreme weather conditions, utilization of green infrastructure in adaptation and informing the citizens about the impacts of climate change and adaptation measures. In 2009-2012 adaptation assessment was made in Helsinki in the BaltCICA project. It included the evaluation of existing adaptation related plans and programmes, impact assessment, assessment of adaptation costs from the city?s perspective and identification of necessary additional adaptation measures. Currently adaptation to climate change has been mainly implemented through different water- related programmes such as Storm Water Strategy and Flood Strategy. As part of the project Climate-Proof City ? Tools for Planning the climate work of City of Helsinki was reviewed with peer review method in 2013. The assessment revealed that different departments are independently implementing their climate work, but the lack of coordination and climate strategy is hindering the effective achievement of the climate goals. Without the coordination of climate work different actors are implementing overlapping and even conflicting measures. Helsinki City Council appointed the climate change coordination task to the Environment Committee and Centre in 2013. Mitigation work is concentrating on the 30% emission reduction work, where the most effective mitigation measures have been identified in the expert workshops. In the project Climate-Proof City the adaptation measures of Helsinki have been prioritized in workshops with multi- criteria analysis method. By using the results from the both workshops the mitigation and adaptation synergies and trade-offs will be studied during the spring 2014, which will form a base for the upcoming city climate roadmap. In addition, the Climate-Proof City project is creating new adaptation planning tools for city planners, which will help them to create climate resilient City of Helsinki. Encouraging signs can be seen as some new land use plans includes both mitigation and adaptation goals. Improvement in the quality of the urban environment has been seen as a positive side effect of many adaptation measures. Most of the adaptation work in Helsinki has been done in pilot projects. The future challenge will be to mainstream the pilot activities and to integrate adaptation to the city processes. New climate roadmap will help avoiding the contradictory measures. However, adaptation will be competing over resources with mitigation and it would be difficult to justify measures that interfere with mitigation efforts. Broader vulnerability and impact assessment and cost-benefit analysis would help to justify and direct the adaptation measures to the most vulnerable areas and groups.

Haapala, A. & Järvelä, E. 2014 Helsingin ilmastonmuutokseen sopeutumisen toimenpiteiden priorisointi. (Prioritization of adaptation measures in the City of Helsinki, forthcoming) Yrjölä, T. & Viinanen, J. 2012. Keinoja ilmastonmuutokseen sopeutumiseksi Helsingin kaupungissa. http://www.hel.fi/hel2/ymk/julkaisut/201 2/julkaisu_02_12_net.pdf. (Climate change adaptation practices in the City of Helsinki)

Climate change adaptation from a planning theoretical perspective ? ambiguous legitimacy in Helsinki

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The relevance of local climate change adaptation has been recognized in both research and policy making. Beyond the recognition of its relevance, actions for adaptation have to be legitimate in order to be successfully implemented. The legitimacy of actions depends on local, socially constructed norms and rules. This study demonstrates for Helsinki, that this can lead to ambiguity and contingency in local adaptation. While there is general agreement on the necessity for local adaptation, there is a wide range of different understandings, what kind of adaptation actions are seen as legitimate. It is often contested, who should intervene into local development, for which reason and based on what kind of mandate, and with which tools. Legitimacy of adaptation depends on the local context, on actor-specific characteristics, formal and informal institutions, and the physical and socio-economic environment (Cashmore and Wejs 2013). At the local level, urban planning and climate change adaptation can be understood as two complementary concepts. From a planning perspective, adaptation is concerned with climate change as one out of many issues planning has to respond to, whereas from an adaptation perspective urban planning focuses on one out of many systems affected by actual or expected climate stimuli. Planning theory can therefore serve as a helpful reference point for examining the legitimation of adaptation in an urban context. The theoretical understanding of urban planning has developed in close interaction with the practice of planning. Planning theory has gone from 'comprehensive-rationalist planning' over 'incrementalism' and 'communicative planning' paradigms towards the search for new pragmatic approaches as presented in 'agonistic planning' (Bäcklund and Mäntysalo 2010). All of these paradigms provide a specific framing and rationale for legitimate action, and they define the relations between citizens, politicians and planners in different ways. The layered co-existence of these paradigms in practice suggests diverse, sometimes contradictive, legitimation for urban planning and - as I claim here- also for climate change adaptation. This study examines the legitimacy of adaptation from a planning theoretical perspective. The case study in Helsinki is based on semi-structured interviews, questionnaires and social network analysis. It analyses, in how far the framing of adaptation and the network constituted by the relations between actors involved in adaptation reflect the traits of specific planning paradigms. The study shows that adaptation is commonly understood from a rationalist perspective as an apolitical activity guided by scientific assessments with local authorities? experts designing and implementing adaptation in Helsinki. Nevertheless, some of the central actors understand adaptation rather as a communicative activity that requires the participation of a wide set of stakeholder and a common deliberation of solutions. The co-occurrence of disparate paradigms in local adaptation results in an ambiguous legitimacy. While from a comprehensive-rationalist view expert assessments and scientific knowledge legitimate adaptation, in a communicative approach adaptation is legitimated by deliberation and a common search for solutions. Actors draw on different premises when retrieving information, striving for cooperation or providing guidance for adaptation. The adaptation network in Helsinki does not comply with the expectations for legitimate climate change adaptation associated with either of the planning paradigms. This leads to contingencies and ambiguity that can impede the successful implementation of local climate change adaptation.

Bäcklund, P. & Mäntysalo, R., 2010. Agonism and institutional ambiguity: Ideas on democracy and the role of participation in the development of planning theory and practice-the case of Finland. Planning Theory, 9 (4), 333-350. Cashmore, M. & Wejs, A., 2013. Constructing legitimacy for climate change planning: A study of local government in Denmark. Global Environmental Change

Risk, role and responsibility of home owners in climate change adaptation

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This article reports from two qualitative case studies in Denmark. The case studies gives insight into how home owners perceive own risk, responsibility and options for response to climate change. This is disused in relation to the role home owners are given in broader climate adaptation planning on municipality and government level. The latest IPCC report concludes that climate change is now not only something we will experience in the future, it is already occurring on all continents. Also in the Nordic countries climate change is moving from being something we have to mitigate, to be a matter we have to consider here and now in forms of adaptation needs. In Denmark climate change is expected to come in form of more extreme weather events. The extreme weather events in form of cloudburst and storm surges Denmark has experienced over the last couple of years have resulted in extensive damages, among those flooding of many private homes. A great number of families have suffered from loses and disruption. This clearly shows how private homes are not adapted to cope with this kind of extreme weather. There is therefore a need to get private homes better adapted to climate change. This article will focus on the role of home owners in this process. To better understand the possibilities and challenges this will pose, there is a need for getting more knowledge about how home owners perceive own risk and responsibility in relation to climate change adaptation. Also we need better insight into the role home owners are given in the broader climate adaptation planning on municipality and government level. Water and wind do not respect property borders or understand the difference between public and private. Climate adaptation can therefore not be seen as separated projects, but every project has to be seen as a part of a broader picture. This forces us to think about responsibility and the understanding of risk in new ways. Those issues will in the article be discussed on the background of two case studies. The first is adaptation of one family homes in the Municipality of Lolland in the southern part of Denmark. The second is an adaptation project in a housing cooperative in Copenhagen. In both cases perceptions of risk, responsibility and options for actions have been studied through observations and interviews with home owners. Further a number of interviews have been made with public employees with responsibility for climate change in both municipalities. On this background the article shows the differences that exist between what the actors sees as meaningful actions and own responsibility. In most cases home owners see collective solutions as the best ones, in the same time as the public campaigns aim at motivate to individual actions. Also the case studies show how the home owners mainly see climate adaptation as the responsibility of the public system. This view is supported partly by public employees, but is challenged by existing law. Finally, even though risk perception among the home owners is closely connected to adaptation actions, those actions is often not connected to broader adaptation planning and are therefore not seen as meaningful from the view of people working with adaptation planning on municipality level. In conclusion, the article argues that there is a need for further discussion and clarification of the role of home owners in climate change adaptation. Only by this we can make sure that home owners get involved in the best possible way in solving the climate challenges, which we are now facing.

Posters

Large-scale hydrological simulations with the HYPE model: uncertainties in the simulated changes and the usability of the simulations in impact studies in the Scandinavian region

Olle Räty; University of Helsinki
Hanna Virta; Finnish Meteorological Institution
Jouni Räisänen; University of Helsinki

Hydrological Predictions for the Environment (HYPE) model were used to construct an ensemble of hydrological simulations for the 21st century climatic conditions in the Scandinavian region. The results are used to demonstrate uncertainties in the simulated changes and the usability of HYPE simulations in climate change impact studies. Climate change induced changes in surface hydrology pose challenges to several socio-economic sectors, such as hydro power production, in the Scandinavian region. The magnitude of, and uncertainties in, the hydrological changes need to be addressed with hydrological modeling. However, for applications that need detailed regional scale information over the whole Scandinavian region options are limited, since there exist relatively few large- scale models that can produce sufficiently high-resolution simulations at daily scales, and their usability in impact studies in Scandinavia is not well known. The latter issue is partially related to the processing of the meteorological forcing data. Due to the biases in climate simulations, statistical pre-processing using so-called delta change or bias correction methods is needed before climate model simulations can be used meaningfully in hydrological modeling. However, since there is no single optimal way to adjust climate model simulations for biases, several methods should be preferably used in parallel. This introduces an additional layer of uncertainties to the climate projections, which are reflected in the range of simulated hydrological changes. Furthermore, this uncertainty has to be also put to the same context with modeling uncertainty and their relative importance needs to be assessed. Hydrological Predictions for the Environment (HYPE) is a semi- distributed, process-oriented model capable of large-scale hydrological simulations with sufficiently high resolution. The computational efficiency of HYPE provides an opportunity to construct a large ensemble of hydrological simulations using several regional climate models and delta change/bias correction methods. Here, we use HYPE to assess hydrological changes in 21st century conditions in the Scandinavian region. Six regional climate models (RCMs) from the ENSEMBLES project were selected as the input for the hydrological model. Furthermore, several well-performing delta change/bias correction methods for daily mean temperature and precipitation were used to process the RCM simulations for the HYPE model. The resulting simulation ensemble is used to evaluate the relative importance of uncertainties in simulated hydrological changes arising from RCM differences and differences between the adjustment methods. Finally, the results are used to demonstrate the usability of HYPE simulations in climate change impact studies. In this study, hydrological simulations for the 21st century conditions in the Scandinavian region were made using the HYPE model. The applicability and potential limitations of HYPE simulations in climate change impact studies are assessed. Finally, the need for taking into account both the RCM and the adjustment method uncertainties when assessing simulated changes is demonstrated.

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How climate change could affect future residential energy demand for space heating in the Nordic countries?

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Brynhildur Davidsdottir; University of Iceland

This study aims at applying decomposition techniques to identify the historical impacts of climate change on energy use for residential space heating. The results of this approach advances our understanding regarding the impacts of relevant factors on the energy demand for space heating of residential buildings for Nordic countries. According to IPCC 2007 report, warming of the climate system is definite, as is now evident from observations of increases in global average air temperatures, and rising global average sea level. Around 25% of GHG emissions are derived from buildings. Thus one of the more important impacts of climate change on energy demand is on the residential sector where climate change is expected to influence energy demand for space heating. To quantify this impact, several methods were proposed including the bottom-up simulation models and top-down econometric models. The method that will be used for this analysis, the ?Index Decomposition Analysis? IDA, was first used in the late 1970s (Ang and Zhang, 2000) and has been applied to energy consumption analysis in many countries and contexts. In this study, the impacts of climate condition as well as the impact of population, floor space, fuel share and efficiency of building shell on final energy use for space heating in Nordic countries will be quantified by applying the Logarithmic Mean Divisia Index (LMDI) approach covering the period from 1990 to 2008. This approach has several advantages when compared to other approaches: the results obtained are consistent in aggregation, zero values in the dataset can be handled, the decomposition results do not contain residual terms (perfect decomposition), and path dependency is avoided (Ang, 2004). For ease of result interpretation and dissemination, the additive decomposition is chosen in our calculations, while the results of multiplicative decomposition can be easily derived from our results. As expected the impacts of population and floor space are positive on annual space heating demand. However, the impacts of buildings shell efficiency and climate were fluctuating in the studied period and they seem to be the most important contributors to the changes in energy demand. Based on the LMDI assessment four climate change scenarios were generated, assessing the impact of climate change on residential space heating demand. The four scenarios were then compared to IEA projections (IEA, 2013). The results show that in the scenarios improvement of the efficiency of the building shell follows the historical trend, with the expected warmer climate, the energy demand for space heating is estimated to be lower than the projection outcomes of IEA scenarios. In this article the impact of key drivers on final energy use for space heating in Nordic countries was analyzed. It was found out that the major contributors to changes in space heating demand are the efficiency of buildings shell and climate. Based on our analysis, the space heating demand is expected to be lower than the findings of the projection by IEA, (2013).

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Validation of two high-resolution climate simulations over Scandinavia

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Before running climate projections with numerical models it is important to validate their performance under present climate conditions. Within the RiskChange project two high-resolution regional climate models were run as a perfect boundary experiment over Scandinavia. The simulations are validated with respect to timing, location and intensity of extreme events. The main objective of the RiskChange project (www.riskchange.dhigroup.com) is to establish a consistent scientifically-based framework for risk-based design using state-of-the-art knowledge of future changes in climate extreme statistics. Very high resolution is required in impact models that are employed to address particular societal needs and risks in terms of adaptation to future climate challenges, (e.g. future storm surge protection of coastlines and low-level lands or drainage systems in urban areas). The purpose of this study is to analyse the properties of high-resolution climate simulations over Scandinavia by testing a hypothesis that dynamic simulations are better at retaining the properties of precipitation, notably precipitation extremes than coarser simulations. When compared to statistical methods the dynamical downscaling has the advantage of retaining the full set of atmospheric variables as well as a physically more realistic description of e.g. complex terrain (e.g. mountain ranges and coastlines) and when the representation and behaviour of extremes are important to be captured in a realistic manner. Here, we present a set of two high-resolution dynamical downscaling simulations on an 8 km grid. Before performing climate simulations under future emission scenarios, it is crucial to validate the model performance under present-day climate conditions to identify systematic biases within the models (Jacob et al., 2007) and to evaluate to what degree the models simulate observed weather. This is done by performing a so-called perfect boundary experiment by dynamically downscaling ERA interim data. The atmospheric models WRF and HIRHAM5 were used as regional climate models (RCMs) in this study. Both models were initialized and driven at their lateral boundaries with ERA-interim data. The simulation period covers 1989-2010 with the first year considered spin-up and discarded. As observational reference we have used both gridded data (E-OBS, Haylock et al., 2008) as well as station observations. Various methods are employed to examine the performance of the RCMs behaviour on a seasonal to sub-daily time scale. Both models exhibit a wet bias of 50-100 % (1-3 mm) in seasonal precipitation. This bias is most pronounced during winter. The lower-resolution reanalysis data underestimates wet-day precipitation in all four season by 13-36 % over the selected cities Bergen, Oslo and Copenhagen. The RCM simulations show a reduction of this underestimation and even indicate a sign change in some seasons/locations. A spatio-temporal evaluation of downscaled precipitation extremes shows that both RCM downscalings are much closer to the observational behaviour. The analysis of higher-order statistical models indicates that short duration extreme precipitation during summer is better simulated within both models.

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Application of Next Generation Sequencing to predict the effects of climate change in the Arctic

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A total of 128 Arctic char samples with circumpolar distribution were sequenced for the whole mitochondrial DNA (mtDNA) using next generation sequencing (NGS). Key regions of the mtDNA were identified and a further 1600 samples were analysed. The project was funded by NordForsk. Climate change has been recognized as one of the most important threats to biodiversity, and the effects are already being felt in the Polar Regions. A greater understanding of how species are adapted to their environment is a central element for anticipating how species will adjust in the face of a changing climate. The Arctic char (Salvelinus salvelinus) has a circumpolar distribution in the Arctic and sub-Arctic regions and is well suited as a model species when predicting the effects of climate change in the Arctic. Mitochondrial DNA (mtDNA) contains genes related to basic metabolic pathways which are temperature dependent. The aim of this research is to identify genetic variation (single nucleotide polymorphisms; SNPs) in the mtDNA related to the temperature gradient across the diverse ecological habitats in which Arctic char occurs. A total of 1728 samples of Arctic char were used in this study and next generation sequencing was applied to simultaneously analyse the whole mtDNA genome for 128 individuals, and key identified regions (amplicons) of mtDNA for 1600 individuals. During the first round of sequencing, a total of 128 samples from across the species range were selected for whole genome sequencing of the mtDNA using a Roche GS FLX genome sequencer. Primers for 28 amplicons were designed from the reference sequence NC_000861 (16.659 base pairs) to cover the complete mtDNA. Samples were divided into 2 groups, each with 64 individuals. DNA from each individual had Multiplex identifying sequences (MIDs) added before sequencing to allow assignment of the resulting DNA sequences back to the individuals. Eight forward MID-primers and eight reverse MID-primers were synthesized, for each of the 28 amplicons. Six regions of the Arctic char mitochondrial genome (D-loop and parts of four coding genes; ND1, ND2, ND5 and ND6) were identified during the first stage of sequencing. These regions were selected for their high levels of polymorphism and the presence of informative functional SNPs (i.e. variation changing the amino acid of the produced protein). A total of 1600 Arctic char were sequenced for these six key amplicons. The samples were divided into 16 groups, each with 100 samples. MIDs were applied allowing a unique identifier for all samples in a single sequence group. Ten forward MID-primers and ten reverse MID-primers were synthesized, for each of the 6 amplicons. In both phases of our experiment the pyrosequencing yielded ~ 210 million filter passed base pairs and generated a large mitochondrial SNP set. By using a genetic approach it?s possible to estimate and map evolution and the divergence of the Arctic char. The results are being used to understand and further investigate both historical and contemporary elements of the phylogeographic structure of the species. Furthermore, this information can be used to forecast the development of the species associated with climate warming. The project was funded by NordForsk.

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The phylogeographic structure of Arctic char (Salvelinus alpinus); a candidate model species to predict the effects of climate change in the Arctic

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The Arctic char is a species under threat, well suited as a model species for monitoring changes in the Nordic areas due to climate change. The NORDCHAR project uses new genetic methodologies as well as conventional ecology methods to make model-based analyses on the effects of climate change. Freshwater fish communities of the Arctic and Subarctic regions of Europe are sparse in species number and include few fish species, compared to the tens, hundreds and thousands found in more southerly regions. However, while true at the species level, increasing numbers of studies provide compelling evidence that within these few species biologically important allopatric and sympatric population diversity is widespread, particularly for the dominant salmonid species Atlantic salmon (Salmo salar), brown trout (Salmo trutta) and Arctic char (Salvelinus alpinus). Climatic models have forecasted pronounced changes on climatic conditions and these changes may have adverse effects in the Arctic and sub- Arctic. The changes may be large regarding the ecology of many valuable species that are utilized in fisheries and in aquaculture. It is very important to understand how the changes will affect the biota to react to the threats and to encourage the opportunities involved. We chose a model species that is especially important for the Nordic societies. The Arctic char is well suited to be used as a model species to understand the effects of climate change. Arctic char is an arctic fish species with circumpolar distribution. Already it can be seen that Arctic char is retreating from its southernmost locations for example in Iceland. 1600 individuals of the genus Salvelinus were included in this study with the vast majority of them belonging to the species Salvinius alpinus. Five regions of the Salvelinus mitochondrial genome covering the D-loop region and parts of four coding genes (ND1, ND2, ND5 and ND6) were selected for the sequencing. The sequence coverage (number of sequence reads) supporting the SNPs per individual, was 39.4 (±12.6). The alignment analysis yielded a total of 546 polymorphic loci, with the greatest number of SNPs identified in the second D-loop region (128) and the region with the lowest number of SNPs being in the ND1 gene (71). Intraspecific genetic diversity in Arctic char was studied as well as the subdivision of phylogeographic groups of Arctic char into western and eastern groups and the hybrid zone in between. Within this research the evolution and the divergence of the Arctic char was mapped. This section of the NORDCHAR project uses new genetic methodologies to analyse the phylogeography and the genetic divergence, within and among Arctic char populations. The Arctic char is well suited as a model species for monitoring changes in the Nordic areas and these results can be used to understand and investigate further both historical and contemporary parts of the phylogeographic structure of the species. All these information can be used to forecast the development of the species associated with climate warming.

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Barriers and enabling factors of climate change adaptation and mitigation among Swedish forest owners

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The present study investigates barriers and enabling factors to behavior that addresses climate change adaptation and mitigation in the forestry sector. Its findings are based on a typology of forest owners drawn from a large quantitative data set. The objective of this study is to examine social and cognitive barriers and enabling factors of personal engagement with climate change adaptation and mitigation. The case study is the Swedish forestry sector. The study´s core hypothesis is that behavior that addresses both climate change adaptation and mitigation can be explained by a) what objectives forest owners pursue with their forestry and b) their perception of climate change risks. Previous research has shown that how forest stakeholders choose among different forestry management options depends on what kind of objectives they pursue with their forestry. The literature knows a large number of typologies that have looked at how forest owners value timber production, recreational benefits, preservation of biodiversity and forestry traditions. The study reviews how certain forestry objectives are related to mitigation and adaptation, and what types of forest owners have a higher or lower level of engagement with these two issues. In addition, this study also draws from the literature on risk perception to examine how behavior that addresses adaptation and mitigation can be explained by perceptions of climate risks, efficacy of adaptive and mitigating actions, and sense of self-efficacy to implement these measures. In detail, the study looks at the influence of experiences with extreme natural events, perceptions of the geographical proximity and urgency of climate risks, trust in climate science and belief in the effectiveness of in risk mitigating measures. Findings are based on a survey study comprising responses from approximately 6000 forestry owners in Sweden. Conclusions are derived from a multiple regression analysis and related statistical methods. Insights into the connection between certain forestry objectives and behavior that aims at adaptation or mitigation will help scientists and policy makers in designing policy intervention that promote both causes. These findings can also help to make research about and for adaptation more applicable and actionable for other forestry stakeholders that want to work with forest owners on climate change.

This presentation will present preliminary findings. The survey will be completed until June, at which the data analysis will commence.

Building Resilient Regions Italian Adaptation to climate change, a multi-level governance prospective

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The propose article is the result of existing collaboration between FLA and KC, to identify potentiality and critical points on the Italian adaptation multilevel governance. We aim to filling knowledge gap, ensuring quantitative impact assessment, guarantee and appropriate financing to taken into account to ensure a successful multilevel adaptation governance. The study considers the FLA working experience on the definition of the guidelines towards the Regional Adaptation Strategy (RAS) in Lombardy, North of Italy, and KC involvement in the EU LIFE+ BLUEAP project that aim to define a Resilient Local Adaptation Plan (LAP) for Bologna Municipality. In particular, this research has the aim to compare the stakeholder?s engagement, area of competencies and risk and vulnerability assessment, to propose a methodology for a multilevel adaptation governance development. The contents are based on two previous articles written by FLA and Kyoto Club. The one developed by the FLA - Guidelines for the implementation of the Regional Adaptation Strategy in Lombardy (RAS) ? had the goal of I. providing a general overview of the vulnerability of the Lombardy region to the impacts of global climate change (GCC) with a list of preliminary possible adaptation measures; II. Reviewing the strategic factors that should be taken into account in the definition of a comprehensive and effective adaptation strategy of Lombardy region. The research shows that a number of socioeconomic sectors in Lombardy face multiple and often interacting impacts due to change in climatic conditions. The other written by Kyoto Club - Adapting to climate change: bologna as a resilient city ? highlight how today we are facing enormous socio- economic challenges that require immediate attention, with the availability of limited public resources - in particular to finance efforts to prevent the long-term effects of climate change, which, in turn, could seriously affect the global economy. We find ourselves in front of a negative feedback loop daunting. The logic of risk management tells us that countries should invest today for the protection of critical infrastructures and centers of economic activity for two main reasons: (1) estimates of future climate- related losses and damage are on the increase and these annual measures may (2) create new jobs to boost economic growth in the shortest possible time. The real problem is that investment in strategic infrastructure is easier to list than to do, in spite of the benefits you can have both in the short and long term. Thus, a new approach, which is based on a meeting of minds in various professions, sectors and geographical areas, and the ability to act decisively in the face of considerable uncertainty about what the best plan of action, could tell. Based on this two experiences we suggest action to filling knowledge gap, ensuring quantitative impact assessment, guarantee a high level of stakeholder involvement and appropriate financing because are all critical key factors to be taken into account to ensure a successful multilevel adaptation governance.

Piero Pelizzaro ADAPTING TO CLIMATE CHANGE: BOLOGNA AS A RESILIENT CITY published on Environmental Engineering and Management Journal September 2013, Vol.12, No. 9 Supplement Guidelines for the implementation of the Regional Adaptation Strategy in Lombardy (RAS) Terradez Mas J.1*, Rossetto M.2, Ballarin Denti A.1,3, Lapi M.1, De Leo G. A.4

Modeling climate change impact on early potato crop and the risk of frost damage in Northern Europe

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The aim is assess the impact of climate change on early potato crop and the risk of frost damage in northern Europe. We developed a degree-day model for early potato crop and their response to future climate change. Over the period 1991-2100, the results indicate a shift in time of the growing season into one month earlier. However, a late planting date (10 April) at latitudes above 55°N may still be favorable compared to an early planting date (1 January) due to the risk of frost damage. Potato (Solanum tubersoum L.) is one of the fourth most important crops after wheat, rice and maize in Europe. The development of the potato is strongly dependent on temperature. In south Europe, high temperature and a declined precipitation amounts is expected to lower the crop productivity in future. At the same time, there is a general tendency to plant potato crops at latitudes above 55°N as the temperature increase in these regions will create a favorable environmental condition for potato to growth. Today, temperature conditions allows to plant potatoes earlier in the season, but this will at the same time increase the risk of frost damage. In this study we aim to assess the impact of climate change on early potato crop and the risk of frost damage in northern Europe. We developed a degree-day model for early potato crop from emergence to maturity and their response to future climate change. The model is based on three different approaches for calculating temperature sums: i) linear growth; ii) upper threshold growth and iii) curve fitted function to estimate the growth of potato. The potential impact of climate change on early potato crop was projected based on a 2°C temperature threshold to estimate the timing of the emergence under two different planting dates: January, 1st (EP1) and April, 10th (EP2) for the time period 1991 until 2100. The climate change signal was assessed using three greenhouse gas emission scenarios (Representative Concentration Pathways: RCP2.6, RCP4.5 and RCP8.5) based on 0.5° latitude x 0.5° longitude gridded data for the period of 2021-2050 (near future) and 2071-2100 (future). For the reference period 1991-2010 we used gridded observed data and compared with climate model data. The results indicate if the potato planted in the beginning of April (EP2) may not be severely damaged by frost. However, the earlier emergence due to early planting (EP1) increases the probability of frost damage in spring during all years. In general, over the period 1991-2100, all model results indicate a shift in time of the growing season into one month earlier, the average annual change correspond to 3.6 days. Our finding suggest that planting potato in April at latitudes above 55°N may be more favorable due to the reduced risk of frost damage in comparison with an even earlier planting date (EP1). In addition, the early planted potato crops may also prevent the risk of attacks by Colorado potato beetle (Leptinotarsa decemlineata, Say) in future. Today, in many of these regions, the beetles are not yet established, but they could become harmful for late potato in future. Key words: early planting, growing degree-day model, potato, North Europe, spring frost damage The impact of climate change on early potato crop and the risk of frost damage in northern Europe was assessed. Over the period 1991-2100, the results indicate a shift in time of the growing season into one month earlier. However, a late planting date (10 April) at latitudes above 55°N may still be favorable compared to an early planting date (1 January) due to the risk of frost damage.

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Quantifying and visualising agricultural vulnerability to climate change and variability in the Nordic countries

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Our research critically analyses and develops methods to quantify and visualise agricultural vulnerability to climate change and variability in the Nordic countries. Our results indicate that the choice of weighting and summarising method significantly determines the vulnerability score of an indicator- based index. We develop an interactive vulnerability tool to validate scenarios and indicators for Nordic agriculture as well as to identify adaptation needs and options to avoid maladaptation. Climate change and variability have direct and indirect impacts on many aspects of agriculture that can result in challenges as well as opportunities. During the last two decades the climate change related opportunities for the Nordic countries, in terms of increased yield potential have been more prominent in the scientific literature compared with possible challenges. This view is however shifting somewhat due to diverging evidences concerning future impacts. One of the largest concerns and uncertainties is the risk of higher crop yield losses due to increased climate variability (IPCC 2014). Thus without a proactive development of adaptation strategies, possible opportunities that may arise with more climate suitable areas cannot be taken advantage of (Olesen et al. 2011). The challenge is to conduct reliable and valid material that effectively can be used as decision support by regional stakeholders, such as farmers, extension officers and county administrative boards. There are many definitions, interpretations and attempts to identify and conceptualise climate vulnerability. These differences have resulted in various approaches to perform vulnerability assessments, both quantitatively and qualitatively (Soares et al. 2012). Our research indicates that the choice of weighting and summarising method, as commonly applied in quantitative composite indices of climate vulnerability, significantly determines the vulnerability score (Wiréhn et al. fc.). This demands an increased transparency concerning methodological choices and uncertainties when displaying vulnerability assessments, for instance, in geographic visualisation. We suggest an interactive visualisation tool that enables assessment of relevant variables related to climate change and variability as well as indicators of sensitivity and adaptive capacity that represent both socioeconomic and biophysical aspects of the agricultural system. The tool opens up several of the processes to assess and quantify vulnerability in order to be transparent about differences in vulnerability scores depending on how the index is composed. Vulnerabilities as well as their drivers could be explored depending on individual stakeholders? focal point as well as selection and weighing of climate variables and indicators. One dimension of the tool is that it can function as a communication platform to enable learning and discussion. Moreover it is a vulnerability assessment method that includes possibilities to validate relevant indicators and scenarios for different agricultural systems in order to identify adaptation needs but also to avoid adaptation measures that potentially could lead to maladaptation. In conclusion, one of the tool?s main objectives is to facilitate a greater understanding about the factors that influence agriculture?s sensitivity or adaptive capacity to specific climate stressors.

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Adaptation to climate change in energy sector in Ltavia

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Energy sector is highly sensitive to climate change. Climate change can impact the production of hydropower energy, wind energy and also energy consumption patterns. Thus there is a need to develop adaptation to climate change in the energy sector integrating adaptation and mitigation approaches. Energy sector is highly sensitive to climate change. Many climate change impacts can be related to production of hydropower energy, wind energy and the energy sector as a whole, including energy transfer, balance between different consumption ways. These impacts are especially important considering growth of renewable energy sources in the overall energy production balance. Thus there is a need to develop adaptation to climate change in the energy sector integrating adaptation and mitigation approaches. The energy sector in Latvia already now have a significant part of renewable energy sources and major efforts are taken to implement energy saving measures. Thus, targets in respect to energy sector for a relatively near future are set on the increase of biomass use and reduction of the energy consumption at the same time diversifying the fossil energy sources. Thus one of main targets in respect to adaptation are set at beneficial use of climate change impacts, relating adaptation targets with increase of biomass use. Further, an evident priority of adaptation measures are set at the reduction of risks of climate change at first in urban environment and in respect to hydropower production. 1, Energy sector is highly sensitive to climate change 2. Adaptation approaches in Latvia should consider growth of renewable energy sources in the overall energy production balance 3. Adaptation to climate change in the energy sector should integrate adaptation and mitigation approaches promoting use of renewable energy in a sustainable approach

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Air quality hazards under present and future climate in Bergen, Norway

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Scandinavian cities often suffer from reoccurring short-time pollution episodes. Information on the past- and future changes in the pollution events is presently not available but strongly requested by decision makers. In this study, we established a link between monthly and seasonal statistics of the local air pollution episodes in Bergen (Norway) and the large (hemispheric) scale atmospheric circulation. The local pollution episodes to a large degree occur during winter-time temperature inversions in the Atmospheric Boundary Layer (ABL), which trap and accumulate emitted traffic exhaust over time. The atmospheric circulation during such episodes is linked to large-scale circulation features such as wintertime anti-cyclonic blockings. Hence, the multi-year variability of these hemispheric circulation features to the large degree controls the local air quality on the monthly and seasonal scales. Even though the temperature inversions themselves and even more so the pollution episodes are very local events and therefore difficult to model with current Numerical Weather Prediction Models, their persistence and scale allow for an in-depth analysis of the pollution episodes on seasonal to multi-decadal times. We present an atmospheric circulation proxy index for the pollution episodes based on local daily mean ECMWF ERA-Interim reanalysis data. A prediction rate (around 70%) and a very high correct null prediction rate (around 95%) are achieved. Because of the high variability of the emissions, the proxy is not thought to provide a basis for case-to-case prediction but only capture interannual statistics of pollution episodes. A high falls alarm rate (around 60%) was therefore expected because of the relaxed thresholds chosen in order to include a large fraction of the pollution episodes. We demonstrate an application of this proxy utilizing CMIP-5 climate model data for projecting the future reoccurrence of the pollution episodes under different climate scenarioes.

Social Acceptability of Climate Change Adaptation in Farms and Food Enterprises - a Case Study in Finland

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This presentation is based on a case study that examines climate change adaptation of farms and food enterprises in Finnish inland provinces. The adaptation strategies of farms and food processing enterprises were in the focus of the study. The key concepts of the study are social acceptability and adaptive capacity. For the study, 27 thematic interviews were conducted during the years 2012- 2013 and the research data were analyzed using qualitative content analysis. The persons interviewed were farmers, food entrepreneurs, managers of food enterprises and representatives of trade organizations and expert organizations. The main research questions were: what kind of threat does climate change pose to farms and food enterprises? What kind of adaptation aspects can be identified in farms and food enterprises? Which factors contribute to the social acceptability of climate change mitigation and adaptation related policy practices? There are different strategies for climate change adaptation (Fankhouser et al. 1999). According to our results, adaptation to climate change in Finnish farms and food enterprises could be characterized as reactive strategy based on localization and decentralization of food supply chain as well as on the development of regional food systems. Alternatively, these strategies may be perceived as autonomous reform processes more consciously linked to energy efficiency than climate change. The social acceptability of adaptation policies depends on the degree of limitation and estimated effects on the profitability of farming. We conclude that values-based strategic partnerships in the food chain could enhance adaptive capacity and resilience of the regions. Further research on regional impacts of climate change with respect to vulnerability and risks is required to provide decision-makers with more comprehensive guidance.

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High-resolution regional climate services based on turbulence-resolving simulations

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Local climate is strongly affected by surface heterogeneity and relief. Observations over complex surface are not representative. Therefore, advanced interpolation methodology is needed to obtain climate at concrete project locations. A methodology based on geostatistical kriging driven by turbulence-resolving model is proposed and demonstrated for infrastructural projects in Western Norway. Presently, the local climate research is not in the mainstream despite the demand for the local climate information from society and industry. The local climate is strongly affected by surface heterogeneity and relief. these effects are both limiting local climate accuracy and projections and constraining the local climate change scenarios. The climate records over complex surface areas are often not representative. These factors indicate the need for an advanced interpolation methodology to obtain the local climate and its projections at locations of concrete infrastructural and societal projects. We propose such a methodology based on combination of the high-resolution geostatistical interpolation by kriging with external drive and hydrodynamical turbulence-resolving modeling. The high-resolution modeling cannot be run for the climate change assessment. Hence, the results of the global (regional) climate simulations (or meteorological reanalysis) are to be used to obtain typical weather regimes, their large-scale characteristic conditions, and probabilities to occur. The turbulence-resolving model runs to recover the high-resolution meteorology for each of these weather regimes. Geostatistical kriging corrects the model results with respect to concrete observational records. The final product for the climate service is the high-resolution maps of the meteorological conditions for each of the typical weather regimes and probabilities of their occurrence. To demonstrate the methodology, a case study of wind/temperature regimes in the Western Norway region have been completed. The model was a Parallelized Atmospheric Large-eddy Model (PALM). The climate records from the meteorological stations of eKlima project were used. The large-scale weather regimes were derived from ERA-Interim reanalysis product. We obtained a 50 m map of climate conditions, which indicate the locations of the extreme wind/temperature anomalies, probability to experience such conditions and their relationship with the large-scale atmospheric circulation. The study demonstrates that accuracy and spatial resolution of the local climate and weather information can be significantly improved. The proposed methodology combines the high-resolution turbulence-resolving modeling and geostatistical interpolation of the observed climate records. In combination with the global/regional climate simulation and historical reanalysis, this methodology can provide more constraint climate change (variability) scenarios for the regional climate change adaptation strategies and concrete infrastructural projects.

Wolf T. and I. Esau: Air quality hazards under present and future climate conditions in Bergen, Norway, Urban climate, in print

Adaptation Strategies and Policy Coordination in EU Member States: A comparative perspective:

Duncan Russel; University of Exeter
Helle Nielsen; University of Copenhagen
Anne Jensen; University of Copenhagen
Eleni Karali; CMCC

This paper draws on data from the European Union (EU)-funded BASE project to compare policy coordination architectures for supporting climate change adaptation strategies in different EU Member States, namely Denmark, Finland, Germany, the Netherlands, the United Kingdom, the Czech Republic, Italy and Portugal. Horizontal policy coordination is an important aspect of adaptation planning as action is required across policy domains necessitating consistent cross-government response. Vertical policy coordination is also an important consideration especially in a multi-level governance system such as the EU where strategies for climate adaptation have been developed from the level of the European Commission, down to the member states and very localised contexts. Drawing on analytical insights from the policy coordination and integration literature, the mix between the informal and formal aspects of different approaches for policy coordination to support adaptation strategies in the studied Member States will be explored including legal instruments and contexts, alongside more administrative ones. As well as categorizing and explaining the different approaches used in different countries, this paper will evaluate and explain the performance of these measures, with the aim of drawing lessons. There are clear lessons that can be learn for climate change adaptation policy coordination: - Strategies are shaped by prevailing political culture/structure - Some states are not geared towards coordination leading to a business as usual approach - Adaptation though should be easier to facilitate than other coordination problems ad the benefits are more immediate - There are interesting innovations that could be more widely adapted regardless of political culture, e.g. Independent expert panels (advice and scrutiny) - Ultimately, there is a need to go beyond the existence of a strategy; understanding its implementation is key.

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Towards an improved European Plant Germplasm System

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The aim of this study is to analyse the constraints in Europe concerning the use of plant genetic resources (PGR). The analysis is based on interviews and questionnaires sent to the stakeholders and the final report is publically available and includes suggestions on how European PGR use could be improved. A wealth of plant genetic resources (PGR) is present in Europe, in gene banks, on farms and in natural and semi-natural environments. However, there are considerable constraints concerning both access and use of these valuable genetic resources. To analyse the constraints, PGR stakeholders from around twenty European countries were interviewed on the current status of conservation and use of genetic resources and about their visions for the future. The major stakeholders were identified as plant breeding companies, public research, gene banks, agro-NGOs and governments. Furthermore, a workshop was held on this issue, bringing together stakeholders from the European countries and their suggestions and opinions were integrated into the analysis. The result from these activities is a report describing the strengths, weaknesses, opportunities and threats of the European PGR conservation and use sector. Also a vision on how this sector should ideally function in the future is presented, as well as strategies on how to reach this vision. The report is publically available at http://www.nordgen.org/index.php/en /c ontent/ view/full/2490/. Important problems identified were underfinanced gene banks, limited support from agrobiodiversity policies for on-farm and in-situ conservation, short term funding limiting pre- breeding and uncertainty with regards to international agreements (CBD, IT) limiting the use of plant genetic resources. Our main message is that it is possible to overcome the weaknesses and threats identified in the European gene bank system and that this can best be done via a concerted European effort. This is of vital importance, since an efficient use of genetic resources is essential for adapting our crops to an increasing human population and a changing climate, and thus ensuring food security.

The work presented is carried within the framework of the PGR Secure project (www.pgrsecure.org), which is a collaborative project funded under the EU Seventh Framework Programme, THEME KBBE.2010.1.1-03, Characterization of biodiversity resources for wild crop relatives to improve crops by breeding", Grant agreement no. 266394. "

Hazard and Risk Maps for the EU Floods Directive in Denmark

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Flooding hazard and risk mapping have been carried out for 10 risk areas involving 22 municipalities. From a 7-step integrated risk analysis method hazard and risk maps are presented and discussed in relation to the usefulness at municipality level in decision- making for risk reduction, risk communication, and climate change adaptation. The purpose of the EU Floods Directive [1] is to identify flood risks and improve preparedness for future flood events and flood risk management. The first step of implementation appointed 10 Danish risk areas and the second step, presented here, deals with the mapping to be used at the municipality level for risk reduction etc. in the third step (2014- 2015). The risk areas in Denmark are appointed due to river flooding (1 area), coastal flooding (4 areas), or a combination of both (5 areas). For the hazard and risk maps an overall integrated risk analysis method based on the German XtremRisK project [2] has been developed that follows a 7-step approach for each risk area: - Step 1: A database including topographical and bathymetrical data, river discharges, and relevant spatial data for different cost categories such as housing, infrastructures etc. - Step 2: The hydraulic boundary conditions are defined for six scenarios; three scenarios in accordance with the Directive and three climate change scenarios. - Step 3: The hydraulic boundary conditions for the six scenarios are used for a reliability analysis of existing flood defences. - Step 4: Numerical inundation modelling using MIKE 21 HD FM is carried out for each scenario. - Step 5: The inundation maps serve as input to calculate the tangible losses due to flooding for each of the scenarios. A Cell-based Risk Assessment (CRA) [3] approach is used for the spatial modelling in the integrated risk analysis. Each flood prone area is divided into uniform polygons (grid cells) at resolutions of 500m, 200m, 100m, 50m, and 25m, respectively. - Step 6: Intangible losses such as cultural heritage, environmental values, and number of affected inhabitants are estimated using the CRA approach. - Step 7: Results from steps 3 to 6 are brought together to obtain the hazard maps and risk maps for each of the six aforementioned scenarios. The hazard and risk maps [4] were published in December 2013 and serve as a robust basis for plans and decisions about risk reduction and risk management that are to be carried out at the municipality level. By applying a detailed and coherent method to the evaluation of flooding hazard and risk mapping in Danish risk areas, the resulting map overlays serve as a robust and dynamic tool for risk management at the municipality level. Looking ahead, however, there still is plenty of room for advances within e.g. damage functions, the assessment and evaluation of intangible losses, and the evaluation of concurrent hazards. Also, the transformation of results into more intuitive tools for decision-making about risk management, risk communication and climate change adaptation needs further work.

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Investigating possibilities for climate change adaptation using local area recharge in urban areas

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In a response to the expected increase in extreme rainfall events in the future, municipalities in Denmark have started to implement plans for climate change adaptation. Especially in big cities the focus is on possibilities for stormwater infiltration. In this study the potential for local area recharge (LAR) in urbanized areas as well as the impact on groundwater levels have been investigated. For two highly urbanized areas two hydrological models have been set up. Both models use the deterministic, fully distributed and physically based model software MIKE SHE coupled with the MIKE 11 code. Thus resulting in a system capable of simulating both surface and subsurface hydrological processes. Special focus has been on detailing the near surface geology and land use data in the model as well as obtaining information on the near surface groundwater levels. The models have been run dynamically and calibrated against groundwater heads and river discharge data. For simulating the future climate IPCCs scenarios A2 and A1B have been used. As the main intention for doing LAR is to lower the amount of water entering the sewer system during a storm water event, one of the focuses have been that LAR should not increase the amounts of sewage water. Neither should LAR result in high increases in groundwater levels causing water on terrain or water seeping into basements. Infiltration of stormwater can also have a negative effect on the groundwater quality by e.g. mobilization of contaminents in the subsurface or infiltration of road water containing salt. In Denmark this is of special importance as all drinking water is groundwater based. Scenarios representing both present and future climate conditions as well as different setups for infiltration have been generated. The infiltration scenarios have been implemented by moving precipitation from paved areas to possible infiltration areas. The resulting effects on ground water levels and amounts of water entering the drains and sewer system have then been evaluated and maps generated showing the areal possibilities for infiltration of stormwater. Finally, the resulting effects on the groundwater quality have been described. The model results indicate that the implementation of climate change adaptation using LAR can have much larger consequences on ground water table rise and increased amounts of sewage water than the effect of the change in future climate conditions alone. In some areas implementation of LAR should be avoided due to the risk of groundwater contamination. The model results illustrate the importance of evaluating the possibilities for using LAR not only in local areas but by looking at climate adaptation plans for larger connected areas as infiltration in one area can have consequences on ground water levels in neighboring areas.

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Urban Cloudburst Planning: Flexibility is key for robustness

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Facing climate change, the municipality of Copenhagen is in the stage of finalizing a detailed cloudburst plan as part of their climate adaptation strategy. The overall purpose of the plan is to ensure that in a cloudburst situation of a certain severity (in this case a future 100-year rain event), there will be no more than 10 cm of water on terrain throughout the city, except in designated areas. In order to concretize such goals it is necessary to define a future scenario and the corresponding design storm on which hydraulic modelling can be based. Once these parameters have been defined the task is clear. However, it must be remembered that climate projections are intrinsically uncertain, i.e. due to the unknown global socio- economic and technical development, and due to the complex and chaotic nature of the non-linear equations governing the calculations behind the projections. Furthermore, there are several uncertainties on city level, such as other plans, environmental concerns, political agendas, etc. So how do we make sure that our efforts into such wide ranging and long term planning are well spent in light of these obvious uncertainties? Based on the current plan for the southern part of Copenhagen, Amager and Christianshavn, we present an example of how the cloudburst-plan has become a flexible and, thus, long term tool for decision makers in the process of adapting the city to the effects of climate changes. The key elements are combining site specific model results with thorough catchment, site and plan analysis to provide just the right level of detailed information that still leaves room for a wide range of different solutions. The solutions are developed through an iterative approach, involving both city- planning, hydraulics, climatography, infrastructure, economics and traditional drainage and it is crucial not to go too far with site specific solutions at this stage. There may be many ways of handling the needed volume or discharge in different available areas such as roads, parks and squares. This method presents an approach and a framework to investigate the solutions space of sustainable and integrated drainage structures into the existing city in the light of climate changes. All the multiform solutions are put together in a solutions table with dimensions according to the dynamic Mike Flood calculations and the available space. The solutions table thus becomes a toolbox for planners and decision makers, from which they can put together the realizable solutions and integrate resiliency to cloudbursts and climate changes into the planning of the city. The flexibility and robustness becomes apparent and manifest, both in the way the solutions are devised and described as measures on the surface, that can easily be modified and adjusted, but also in regards to the planning process, where the solutions are adaptable to the many other concerns and priorities of a city, and the plan in that way becomes resilient towards the climate changes and unforeseeable developments the future will inevitably bring.

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Life Cycle Assessment as a decision support tool in policy making: the case study of Danish spring barley production in a changing climate

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Life Cycle Assessment can guide policy makers in the choice of the most effective measures to adapt to climate change in crop production. A case study involving spring barley cultivation in Denmark under changed climate conditions has been performed using primary data from future climate scenarios One of the most contributing sectors to the net anthropogenic greenhouse gas (GHG) emissions is agriculture, which including crop and livestock production, forestry and other land uses is responsible for about one quarter of the emissions (IPCC, 2014). The implications of climate change for agricultural systems are both in terms of crop productivity and environmental sustainability. Environmental sustainability can holistically be evaluated through Life Cycle Assessment (LCA). LCA is a decision support tool, aiming to quantify the potential environmental impacts of a product system?s input and output during its life cycle. LCA can avoid the shifting of a potential environmental burden between life cycle stages or different categories of environmental impact. The use of LCA to assess and compare current crop production and management alternatives is consolidated, but this study shows, how it can also effectively predict changes in the environmental impacts of production systems as a result of the changing climate. The objectives of this study within the Nordforsk project ?Sustainable primary production in a changing climate? are: (i) to perform a life cycle assessment modelling the environmental impact of spring barley production expected in Denmark in the second half of this century, if the climate changes according to the IPCC A1FI scenario; (ii) to compare alternative future scenarios, both excluding and including adaptation measures, i.e. early sowing and cultivars selection. Considering that the lack of primary data is one of the most important drawbacks affecting the reliability of LCA studies, there is a need to base future predictions on measured data from the system studied. This is rarely possible when addressing the impacts of future climate changes. However, in this study the main input data originate from experiments where spring barley cultivars are cultivated in a climate phytotron under controlled and manipulated treatments mimicking the future climate. Effects of changed climate both on crop productivity and crop quality are included, as well as implications of extreme events, simulated through a long heat wave. A baseline scenario describing the current spring barley cultivation in Denmark was defined, and the expected main deviations from the current cultivation were identified (differences in pesticide treatment index, modifications in nitrate leaching and change in crop yield). This led to the definition of a set of alternative scenarios under future climate conditions, which have been compared to provide policy makers with suggestions for controlling the potential environmental impacts of future spring barley cultivation. LCA results show an increase of the potential environmental impacts for future spring barley cultivation in Denmark for all scenarios considered, except one ideal scenario where yield is not limited by environment or management. The main driver of the impact is the expected change in crop yield, therefore potential adaptation strategies should mainly focus on influencing this parameter. The selection of proper cultivars is the most effective way for reducing future environmental impacts of spring barley in Denmark.

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Costs and benefits of technologies for adaptation to climate change, examples from the agricultural and water sectors in Lebanon

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The presentation provides a framework for evaluating the costs and benefits of technologies for adaptation at the local level. Two examples of technologies that have been implemented in the agricultural and water sectors in Lebanon, including the benefits and costs, are presented. Traditionally, adaptation has been viewed as a matter for national governments, which are responsible for flood preparedness, irrigation schemes, research and development of improved seeds, dams and water availability. In an ideal world, individuals and communities would act autonomously without government planning or intervention, though taking account of social, political, cultural and market institutions. Nevertheless, Fankhauser et al. (1999) conclude that often this is not the case. Continuous constraints such as inadequate information and resources ensure that governments remain in lead positions, when it comes to taking adaptation initiatives. In order to move towards more autonomous adaptation, governments will have to improve conditions for individual households and communities in terms of institutional and socio-economic environments. This is in line with general economic theory stating that government involvement is necessary, whenever the market is not working well, given the existence of information irregularity, negative externalities and public goods. This is evident, for example, in drought situations, where farmers intensify irrigation and subsequently overexploit existing water reservoirs, and consequently incur a negative externality in terms of depletion costs. To avoid imperfect information for farmers and to empower them to make the right choices, more local level case studies including the benefits and costs of implementing adaptation technologies, are required. The presentation provides a framework for evaluating the costs and benefits of technologies for adaptation at the local level. Two examples of technologies that have been implemented in the agricultural and water sectors in Lebanon, including the benefits and costs, are presented. The results contribute to the knowledge base on benefits and costs for both planning and funding technologies in the context of adaptation to climate change, in addition to prioritizing between various adaptation technology investments. Based on local-level data from the agricultural and water sectors in Lebanon, the presentation provide two examples of the economic feasibility of implementing selected adaptation technologies. The results show that the technologies could be deployed at low cost and with relatively little effort. The examples of rainwater harvesting from greenhouse roof tops and conservation agriculture are low-cost technologies applicable for the agricultural and water sectors, which require little or no capital input. Creating an enabling environment for the transfer diffusion of the technologies for adaptation is an immense part of the technology transfer perspective.

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Decision making in high-stake, low-probability climatic events Looking beyond standard economics to explain relevant behavioral anomalies

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High-stake, low-probability climatic events set the stage for decision-makers falling prey to biases and inter-dependencies. This paper explains decision-makers anomalous adaptation behavior through the glass of behavioral economics. In so doing, it sheds light on some significant developments in decision-making that have occurred in economics in the last few decades. Climate change research has become increasingly interdisciplinary. The literature in the area, including landmark reports such as the IPCC reports and the Stern review, have progressively presented how economics contributes to the research. Frequently, what is covered in such reports includes risk, decision making, cost benefit analysis and other formidable analytical tools. The models these are founded upon are appealingly logical and elegant. Thus, as a researcher, one can easily become captivated by economists classical recommendation for decisions involving risk and uncertainty and disregard that such decisions are not being made by the economic man -Homo economicus- described in these models. Thereby, neglecting that the real decision-maker is not this perfectly rational and self- interested agent; that when confronted with a decision under uncertainty he relies on simple heuristics which are a direct reflection of his cognitive limitations and biases; or that the intricate inter- dependencies of the world lead him to exhibit other-regarding preferences. This paper proposes that such behavioral deviations from standard economic assumptions should be acknowledged and further investigated. As is often the case with inter-disciplinary studies, researchers have an inclination to limit themselves to drawing from the theories that make up the founding blocks, i.e. standard economics, and fail to follow the evolution or the emerging branches of the discipline as well, i.e. prospect theory, present bias, inequity aversion and other theories that have undergone the neo-classical repair shop". In an attempt to contribute to the correction of this tendency, the paper offers a new perspective to climate change researchers interested in drawing from behavioral (and experimental) economic theories. It provides an intuitive introduction to a wide range of relevant behavioral anomalies. The paper starts from the perspective of the individual and the cognitive traits that lead him astray from efficient climate change adaptation. Then it moves on to group dynamics, where other-regarding preferences affect the efficient outcome. These are exemplified throughout the paper in a climate change setting, though the focus may be on one particular anomaly, i.e. over- or under- updating probabilities subject to the type of risk exposure. Overall, the paper should help enable researchers make key economic assumptions more realistically and ultimately achieve a more powerful economic analysis. " The real world decision maker has intuitive and analytic thinking skills that work proficiently, most of the time. But when facing high-stake, low-probability climatic events his mode of thinking may well lead him to exhibit behavioral anomalies such as loss aversion, ambiguity aversion, myopia, pre- commitment preference, over- or under-updating, coordination failure and inequity aversion. Though, much of the knowledge of behavioral anomalies has yet to be translated from research into actionable decision-making, the paper presents useful tools for researchers who believe that improving decision making lies in the careful empirical study of how decisions are actually made.

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The benefits of early warnings for food security: Case studies in Malawi and Zambia

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This study identifies the challenges in the generation, dissemination and use of early warning services ? seasonal outlooks and short-range multi-hazard early warnings ? as a tool in disaster management and climate change adaption in two Sub-Saharan countries, Malawi and Zambia, and assesses its potential societal benefits and factors behind benefit creation. Food insecurity is a pertinent disaster risk in many Sub-Saharan countries. It is exacerbated by abnormal rainfall causing poor yields or total loss of harvests; with the situation expected to further deteriorate due to climate change. Impacts of food insecurity are wide-spread and require a response from governments and aid organisations. Integrating reliable early warning information into farming practices and disaster management has the potential to mitigate these risks and to improve the preparedness of the key stakeholders. Managing current disasters is tightly linked to adaptation to climate change, as reduced vulnerability to current disasters is a key in adapting to the impacts of climate change. Early warnings can be seen as a tool in adapting to climate change, as successful implementation of early warning information and the consequential decreased vulnerability to current extreme weather phenomena will increase the possibilities to adapt also to the variability of future climate. This study identifies the challenges in the generation, dissemination and use of seasonal forecasts and short-range multi-hazard early warning system information in disaster management, and assesses its societal benefits. Weather Service Chain Analysis (WSCA) (Nurmi et al., 2013; Perrels et al., 2013) is used as a framework to analyse the value creation of the early warning information. WSCA aims at accounting for inadequacies in the generation, dissemination and use of weather information, as it describes the decay of the benefit potential based on a decomposition of the information flow, ranging from information generation to benefit realization for the end-user and society as a whole. Furthermore, WSCA is analysed, in conjunction with previous studies on the limitations in the use of meteorological information (e.g. Patt & Gwata, 2002), with the aim to further develop the understanding behind the value of early warning services. The case studies draw on 45 semi-structured interviews with governmental agencies and ministries, private sector stakeholders, UN agencies and NGOs in Malawi and Zambia. Preliminary assessment indicates that there are several deficiencies in the current value creation of early warning information. Seasonal forecasts are actively used by the government sector to estimate the need for response to food insecurity situations. However, as identified by the WSCA, it is only of value if it performs better than climatology. Furthermore, the dissemination of seasonal forecasts should focus on cases exhibiting a clear signal of abnormal rainfall. In these cases, it is not currently used to its full potential to mitigate the potential risk; stemming from its lack of dissemination to farmers. Systematic multi-hazard early warning system does not exist in either country, and based on the data, there are several obstacles behind the use and value creation of the information.

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Estimating the sowing date of spring crops in Finland based on temperature using Bayesian methods

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In Finland, the date of spring sowing can be an important determinant of final crop yield. This paper describes a method for quantifying the dependence of sowing date on temperature, using past observations. Such a dependency may have important implications for guiding farm-level adaptation options under changing climate. Analysis of historical records suggests that the growing season in Finland lengthened during the twentieth century, but more significantly at the start of the season than at the end [1]. Further lengthening is projected for the future under a warming climate [4]. In general, farmers aim to sow cereals as early as possible to utilise moisture from snow melt, exploit abundant solar radiation and avoid late harvesting in autumn. As conditions become warmer, higher temperatures can shorten the vegetative phase of spring cereals and reduce yields, but farmers can avoid this by sowing crops earlier in the spring [3]. The decision to sow is based on a complex interplay between soil characteristics, past weather conditions, and the expected course of warming in the early summer. To predict accurately the sowing time, a physical model would be required that estimated soil temperature and moisture balance as a function of observed weather [3]. Such a complex approach is often not feasible. When performing simulations for past years observed weather data and sowing dates can be provided as input to crop models. Another option is to use a fixed sowing date. However, under a changed climate both approaches are likely to lead to implausible situations. Few studies in Finland have attempted to predict the timing of sowing based on weather. One earlier study on spring wheat, based on data from 1970?1990, determined that sowing occurred when daily mean air temperature exceeds 8°C [2]. In this study, sowing dates of spring-sown wheat and barley from three locations in central and southern Finland during 1994?2009 have also been related to temperature. Moving averages of observed daily mean temperature were applied, both to prevent erroneous influence of anomalous cold or warm spells on the sowing date, but also to acknowledge that farmers are able to draw on information on previous and forecasted weather in making sowing decisions. Several rules consisting of different lengths of moving averages and different threshold temperatures were tested. For each rule the sowing date was specified as the day when the threshold temperature is exceeded. The differences in days between the observed and estimated sowing dates were calculated and Bayesian methods were used to determine the rule that replicates best the behaviour of farmers across different parts of Finland. On average, a threshold temperature of 10°C gave the smallest difference in days between the observed and calculated sowing dates for both crops. A simple rule has been identified for calculating sowing dates from mean temperature that gives reasonable estimates of the sowing dates of spring wheat and barley observed in fields on Finnish farms. This differs somewhat from a previous formulation based on earlier data. Bayesian methods provided a systematic way for approaching the problem and expressing the result as probabilities. This rule, if applied in crop model simulations for Finland, could offer a reference point for comparing the effects on cereal yield of different sowing strategies as an adaptation to climate change.

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Remote sensing estimates of impervious surfaces for pluvial flood modelling

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This paper investigates the accuracy of medium resolution (MR) satellite imagery in estimating impervious surfaces for European cities at the detail required for pluvial flood modelling. Using remote sensing techniques enables precise and systematic quantification of the influence of the past 30-40 years of urban development towards the impacts of high-intensity rainfall In recent years, it has been demonstrated that cities globally have become increasingly exposed to the impact of pluvial flooding (Field et al., 2012). There is evidence that the observed change in risk may have been caused by a combination of large increases in the extent of urban cover and climate change (Field et al., 2012) (Angel et al., 2011). Urban environments are dominated by impervious surfaces (IS), which are sealed areas through which water cannot penetrate, as road infrastructure, buildings and other paved areas occupy a main share of the urban land area (Weng, 2012). Hence impervious surfaces are often used as an indicator of urbanization. Changes in the quantity of impermeable surfaces (IS) have important implications for the hydrological response of a catchment. Replacing natural land cover with artificial surfaces causes a reduction in infiltration capacity and surface storage capacity (Butler, 2011)(Parkinson and Mark, 2005). Water moves faster over sealed surfaces than over natural surfaces, and high IS cover subsequently increases run-off volumes, peak flows and flood frequency. MR satellite imagery offer a complete spatial and temporal coverage of global urban land cover changes during the past 30-40 years, and can be used as a basis for accurate quantification of small scale changes in IS. This research addresses the accuracy and applicability of medium resolution (MR) remote sensing estimates of IS fractions, e.g. for urban hydrological modelling. A main objective is to show that NDVI may be an accurate measure of sub-pixel imperviousness for urban areas at different geographical locations, and that it can be applied for cities with diverse morphologies and climatic conditions. For this purpose the accuracy of NDVI based estimates of IS have been examined for eight different cities in Europe at 30m and 60m spatial resolutions. The impervious surface fractions are estimated using pixel- based Ordinary Least Squares (OLS) regression models between Landsat 8 Maximum Value Composite (MVC) NDVI and actual imperviousness, which is measured manually from high resolution images. The potential spatial transferability of the city-specific regression models was addressed by examining the homogeneity of the models. This was done by quantifying the absolute mean errors and biases between all possible combinations of regression models and urban areas. The results of the accuracy assessment show that the absolute mean errors of the NDVI based IS estimates are 6-11% and 5-9% for the analyses with 30m and 60m spatial resolutions respectively. The low variability in accuracies across geographical locations suggests that an equally strong relationship between NDVI and IS fractions exists for many other urban areas, both within and outside of Europe. The findings indicate that MR satellite imagery can provide accurate estimates of the quantity and location of IS and changes herein, for cities at different geographical locations, and at the detail required by pluvial flood models.

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The climate change impact of a high-end CO2-emission scenario on hydrology

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Impacts of a high-end climate scenario (6 degrees) on water resources have been assessed for the Odense River catchment in central Denmark using a fully distributed coupled surface water/groundwater model based on the MIKE SHE code. Impacts have been analysed for streamflow, groundwater heads and dryness indices. Worst case scenarios of climate change in the latest IPCC report describe average global surface warming by 2100 of up to 6 degrees from pre-industrial time. This study highlights the influence of a high-end 6 degree climate change on the hydrology for the 486 km2 Odense River catchment in central Denmark. Outputs from the climate model, ECEARTH-HIRHAM, are downscaled using simple bias correction for daily reference evapotranspiration and temperature, while Distribution Based Scaling is used for daily precipitation data. Both the 6 degree emission scenario and the less extreme RCP4.5 emission scenario are evaluated for the future period 2071-2099. The downscaled climate variables are applied to a fully distributed, physically- based, coupled surface water ? subsurface model based on the MIKE SHE model code. The 6 degree scenario is characterized by large year round temperature increases of up to 5.7 ?C, with increasing reference evapotranspiration as a result. Precipitation increases in especially winter and autumn, while summer experiences a decrease in precipitation. For the Odense sub- catchment, this means an annual precipitation change of +7% from the historical to future period (RCM-GCM values). The 6 degree emission scenario causes large changes in the hydrology of the catchment. In spite of the precipitation increase, the actual evapotranspiration increase of +17% for the 6 degree scenario causes decreasing stream discharge for most of the year. This is especially critical in the summer period, potentially leading to problematic ecological consequences as stream and wetland desiccation. Furthermore the changes also lead to increasing difference in stream flow between the seasons as January and February has the highest discharge values and will experience further increase in the future. The soil moisture and evapotranspiration indexes SMDI and ETDI developed by Narasimhan and Srinivasan (2005) were used to characterise the dryness in the catchment and to evaluate how the climate change affects the root zone water balance. The high-end scenario showed larger temperature increases and large chances in especially winter reference evapotranspiration and precipitation. The stream discharge impact caused larger seasonal differences from winter to summer, as winter discharge was increased while most of the remaining year had decreasing discharge values. Generally the climate change resulted in a lowering of the groundwater head and a substantial increase of dryness in the root zone, represented by an overall lowering of the agricultural dryness indexes. With the very large climate change represented by the 6 degree scenario the climate model uncertainty represented by the inter- model variability becomes of relatively less importance compared to the usually studied more moderate climate change scenarios.

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The Role of Citizens in Resilience to Climate Change - A Review of Current Research

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This research presents a literature review of citizens? role in resilience in relation to climate change adaptation. A systematic literature search in Scopus and Web of Science marks the basis of this paper and for formulating a new research agenda within resilience and participation. More incidents of heavy rains and storm surges, as a consequence of climate change, challenge the existing water systems, leaving a pressing need for creating innovative and resilient solutions. The concept of resilience is thus increasingly occurring as a notion related to research within climate change adaptation of cities To support more resilient water systems, green and blue infrastructures are being discussed as a supplement to traditional below ground water systems in order to integrate the handling of storm water with urban development and environmental protection. Involving citizens is a necessity for developing these innovative approaches and solutions benefitting to the functions of these social-ecological systems. In some fields, such as the field of natural habitats, it has been documented that citizens have taken active part in monitoring and implementation phases to increase ecological resilience of a system (Olsson and Folke 2001; Folke 2006). However, in urban wastewater management there are few documented examples, as this has mainly been handled by wastewater utilities and professionals (Lindegaard 2001). In this field, citizens are traditionally regarded as users or costumers of a service (Rouse 2007). The key question of this paper is thus how the role of citizens is approached and documented in resilience research and the paper explores how different fields dealing with resilience regard the role of citizens. Focusing on the Western world, literature searches carried out in Web of Science and Scopus identify scientific articles dealing with ?citizens? in ?resilience?. The search outlines different fields and how these interpret the role of citizens and engage with citizens in practise in the form of users, local communities or residents etc. . Based on the literature review of citizen roles in resilience a new research agenda within resilience, climate change adaptation and participation is presented. This article contributes with a state-of-the-art of citizens? involvement in resilience and show experiences from the resilience literature, which is of relevance for developing the approaches to resilience within different fields. Furthermore, the exploration of citizens? participation within resilience research is especially relevant for the development of new approaches to climate change adaptation of urban water management. Further research is needed within urban water management on the role of citizens in creating innovative and resilient solutions to climate change.

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