A Framework for Nordic Actor-Oriented Climate Adaptation Research

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A Framework for Nordic Actor-Oriented Climate Adaptation Research

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ABSTRACT: The past ten years have seen a substantial increase in research on climate change adaptation, but a large gap remains between adaptation research and action. Adaptation researchers have failed to demonstrate the relevance of their findings to practitioners and policymakers, forcing stakeholders to base their views and decisions on other kinds of information. In addition, in sectors such as agriculture, forestry, nature conservation, urban planning, water management and energy supply, adaptation has been studied separately from mitigation, which contradicts the reality of many practitioners. This paper identifies five bottlenecks to the use of adaptation research in adaptation practice and policy. These bottlenecks have gone unnoticed because the traditional framing of adaptation does not adequately consider the notion of agency, often rendering stakeholder interactions ineffective. Knowledge and use of actor-oriented theory when analysing and discussing adaptation needs and options could serve to find ways to overcome the bottlenecks and narrow the gap between research and action. The paper presents a novel framework for actor-oriented adaptation research that is being conducted within the Nordic Centre of Excellence for Strategic Adaptation Research (NORD-STAR). It frames climate adaptation as addressing both the impacts of climate change and the consequences of climate policy. Two methodological approaches – modelling and visualisation, and policy analysis – are applied to three thematic issues: land-use change, energy transitions, and insurance and finance.

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1. Introduction

The Nordic region comprises Denmark, Finland, Iceland, Norway and Sweden, as well as the Danish associated territories of the Faroe Islands and Greenland, and the Finnish associated territory of Åland. The Nordic region has a combined population of 25 million, and all five countries are ranked within the top 25 of the Human Development Index (UNDP, 2011). The Nordic countries have long cooperated in economic, political and environmental issues, with much of this cooperation taking place through the Nordic Council, which was established in 1952. The countries' political systems are similar, characterised by representative democracy with highly devolved decision-making authority at the local level.

As the reliability of regional climate change projections continues to increase, so does confidence in expected changes in the Nordic countries. Although regional variations exist and uncertainties remain, Nordic countries will experience an increase in mean temperature, with the greatest warming in the winter, as well as an increase in annual precipitation (IPCC, 2007). This level of warming is considerably higher than the expected global average. In addition, precipitation (both rain and snow) is likely to increase in the winter, and throughout the year, one-day precipitation extremes are expected to be more severe (IPCC, 2007). Sea-level rise will pose challenges for low-lying areas along both the Baltic and the North Sea coasts (BACC Author Team, 2008).

The Nordic countries have made great advances in climate adaptation research over the past ten years, and they have also put adaptation on their domestic political agendas. Yet the impact of adaptation research on adaptation policy and practice has been low, both in the Nordic region (e.g., Westerhoff and Juhola, 2010; Dannevig et al., 2012) and elsewhere (e.g., Vogel and O'Brien, 2006). Based on a review of the literature and on empirical research, this paper identifies five bottlenecks to the use of adaptation research by stakeholders. The bottlenecks are related to the prevailing conceptualisation of adaptation, the type of scientific knowledge considered to support adaptation action, and stakeholders' realities of adaptation decision-making.

The paper then proposes an actor-oriented approach to adaptation research to overcome these bottlenecks. Central to this approach is to consider adaptation as addressing not only the impacts of climate change but also the consequences of climate policy. This new conceptualisation is now being applied in the Nordic context; it should produce research results that can more directly contribute to adaptation policy and practice by relating to stakeholders' roles and priorities, and the circumstances in which they make decisions.

2. Nordic adaptation challenges

Future changes in climate and sea level will have a range of impacts on the Nordic region, affecting ecosystems, the built environment and other physical infrastructure, and economic sectors such as forestry, agriculture, fisheries and tourism. The Nordic region is not considered particularly vulnerable to climate change (Greiving et al., 2011), yet economic loss and damage could be significant (Hallegatte et al., 2011), and changing climate extremes could lead to additional fatalities from weather-related hazards (Wichmann et al., 2011; Rocklöv and Forsberg 2010). In addition, ecosystems could undergo irreversible change, especially in the Arctic and Subarctic regions (IPCC 2007; Kirilienko and Sedjo, 2007). Not all impacts of climate change will be negative: climate change can also create opportunities, for example for agriculture and tourism (Tervo, 2008).

Adaptation would serve both to reduce vulnerability to the adverse effects of climate change and to prepare for new opportunities. Compared with other parts of the world, the Nordic countries have high adaptive capacity (Greiving et al., 2011), although this may not necessarily be the case for individual communities, households and firms (O'Brien et al., 2004; Keskitalo et al., 2011; Juhola et al., 2012). Moreover, complacency due to the low perceived risk of climate change could mean that despite the high adaptive capacity, action is not taken to prepare for potential impacts (O'Brien et al., 2006; Johannessen and Hahn, 2013). On the whole this means there are several adaptation challenges in the Nordic countries, both for research and policy.

2.1. Adaptation research in the Nordic countries

Climate change became a priority for the Nordic countries when the Intergovernmental Panel on Climate Change (IPCC) was established in 1988 and the United Nations Framework Convention on Climate Change (UNFCCC) was agreed in 1992 (Nordic Council of Ministers, 1995). The Nordic approach to climate change would mirror the way in which other environmental issues had been analysed and tackled, with policy informed by scientific research and driven by the political resolve to protect the environment (Sairinen, 2001; Engström et al., 2008). In the 1980s, for example, acid rain and the depletion of the ozone layer had highlighted the transboundary nature of environmental issues and the need for political co-operation to address these issues.

A long track record in weather observation formed the basis for strong Nordic capacity in climate monitoring and for an early research interest in climate modelling. Climate monitoring and modelling were thus the starting points for Nordic climate research in the 1980s and early 1990s (NordForsk, 2009). Nordic research then evolved along a similar path as climate research elsewhere in Europe (Biesbroek et al., 2010). Early research aimed primarily at understanding the climate system, with an emphasis on system dynamics, causal attribution of climate change, and modelling of future climate. The Nordic contribution in these fields of research concentrated on atmospheric modelling and the carbon cycle (NordForsk, 2009).

In the mid to late 1990s the scope of Nordic climate research was broadened to include the assessment of impacts of climate change and the evaluation of options to mitigate climate change by reducing the emission of greenhouse gases. Much of the research on impacts was on ecological systems and biodiversity, the marine environment and the Arctic (NordForsk, 2009); more recent studies include the assessment of wider impacts on society, including consideration of vulnerability and adaptive capacity of local communities and economic sectors. And whilst early studies tended to focus on specific impacts of climate change, such as increased precipitation and consequent flood risk, recent research takes a more integrated approach that considers current vulnerability and non-climate concerns.

At around the turn of the century Nordic climate impact researchers began to address the issue of adaptation to the impacts they had identified. Global climate models were downscaled and regional and national scenarios were developed to identify adaptation needs. Finland was a pioneer in this kind of adaptation research (Carter et al., 1995; Carter, 1998). Once the IPCC (2007) recognised a need for adaptation irrespective of the success of mitigation efforts, research on climate vulnerability and adaptation began to flourish. Growing interest in vulnerability and adaptation offered an opportunity for social scientists to complement the work done by climate impact researchers, introducing the notion of values, norms and institutions, and issues of governance (Biesbroek et al., 2010). In this field of research Norway was a frontrunner (O'Brien et al., 2004; O'Brien et al., 2006). In December 2006, the first Nordic adaptation research workshop brought together in Oslo some twenty Nordic scientists and government experts to take stock of the Nordic adaptation research experience so far, and to foster collaboration.

Nordic research on climate adaptation has since made great advances. The high quality and interdisciplinary nature of the research, in particular the growing involvement of the social sciences, are internationally recognised. Supported by a variety of funding avenues, hundreds of Nordic academics are now engaged in adaptation research. High-profile Nordic research programmes that focus in part or primarily on adaptation include the Danish Centre for Regional Change in the Earth System (CRES), the Finnish Research Programme on Climate Change Adaptation (FICCA), the programme Climate Change and Impacts in Norway (NORKLIMA), and the Swedish Research Programme on Climate, Impacts and Adaptation (Mistra-SWECIA). These programmes increasingly view adaptation as a social process. Research addresses, amongst other things, the role of climate information and scenarios as a basis for adaptation planning and implementation, determinants of vulnerability and adaptive capacity, and the role of social learning in understanding and reducing climate risk.

2.2. Adaptation policy in the Nordic countries

The Nordic countries have a long tradition in environmental policymaking and have been referred to as ' pace-setters' for environmental policy within the European Union (EU) (Börzel, 2002). The progressive nature of Nordic environmental policy likely reflects early concerns over the sustainability of the use of natural resources and energy, which arose as the Nordic countries developed into high-technology and high-consumption societies (Jä rvelä and Juhola, 2011). These concerns also triggered early action on climate change; in the early 1990s Finland, Sweden and Norway were the first countries in the world to introduce a carbon tax (Sairinen, 2003). In relation to adaptation, however, approaches in the Nordic region have been more diverse, with some countries taking more initiative than others. Approaches to adaptation also differ in terms of the stakeholders involved, the planning process and the timescale of implementation.

In 2005 Finland was the first EU country to publish a National Adaptation Strategy (NAS) (Marttila et al., 2005). Based on climate impact scenarios, the NAS presented a range of possible adaptation measures to be mainstreamed by national sectoral authorities into existing practices and future planning. The first evaluation of the NAS found that implementation had progressed well in some sectors, including the environment administration, whilst other sectors were still to take their first steps towards implementing adaptation (Ministry of Agriculture and Forestry, 2009). One notable barrier to implementation has been the absence of links between the national and local levels (Juhola et al., 2012), as the NAS only focused on the national level (Juhola, 2010).

In Sweden the publication of the final report of the Climate Change and Vulnerability Commission (2007) stimulated the development of adaptation policy that is based on stakeholder engagement, consensus and negotiation. The report identified risks of climate change pertinent to Sweden, and assessed the vulnerability of nature, people and socio-economic activities to the realisation of these risks. The report recognised the responsibility of municipalities and county administrative boards to initiate adaptation efforts, to be supported by government financing (Commission on Climate Change and Vulnerability, 2007). Progress on adaptation at the municipal level to date has been modest (Granberg and Elander, 2008; Nilsson et al., 2012); lack of coordination and the absence of methods and traditions to build institutional knowledge are seen as barriers to progress (Glaas et al., 2010; Nilsson et al., 2012).

Denmark published its ten-year national strategy for adaptation in 2008 (Danish Government, 2008). The strategy noted the need for timely adaptation, but suggested that most adaptation would be autonomous (Swart et al., 2009). The purpose of the Danish strategy is therefore to develop a legislative, financial and technical framework within which authorities, companies and individuals can adapt according to their needs. The government would have only the initial responsibility of providing information and coordinating action amongst stakeholders. Within the municipalities, adaptation is considered a technical challenge, mainly related to water management (Lund et al., 2012). However, recent developments suggest a need for municipalities to be more proactive on adaptation, and national regulation has been adopted to encourage municipalities to take initiative (Climate-Adapt, 2012).

Adaptation action in Norway was stimulated by early research on vulnerability and adaptive capacity at the local level (O'Brien et al., 2004; O'Brien et al., 2006; Næss et al., 2006; Rød et al., 2012), although a comprehensive adaptation policy or national strategy has yet to be published. In 2009 the government established an interdepartmental coordination team, led by the Directorate for Civil Protection and Emergency Planning, to enable all stakeholders to conduct their roles and meet their tasks as relevant to adaptation (Directorate for Civil Protection and Emergency Planning, 2009). The coordination team has outlined adaptation responsibilities of national sectoral agencies, and identified best-practice examples at the regional and municipal level (Directorate for Civil Protection and Emergency Planning, 2009). Næss et al. (2005) found that adaptation action in Norway had been hampered by weak incentives. At the municipal level, adaptation has been implemented more slowly than other local environment initiatives (Aall, 2012). It has faced a number of constraints, including insufficient resources and lack of expertise (Dannevig et al., 2012).

Adaptation in Iceland has so far been overshadowed by mitigation. According to Iceland's Climate Change Strategy, the government will prepare for adaptation to climate change, but no specific adaptation strategy has

been published (Ministry for the Environment, 2007). The measures proposed by the Climate Change Strategy include the establishment of a scientific committee to assess the impacts of climate change, giving priority to the risk of sea-level rise. Risks and opportunities specific to Iceland include the possible increase in navigation and oil exploration in the Arctic, better conditions for agriculture (Ministry of the Environment, 2007), and a potential increase in yield of commercial fish stocks, a major source of income for Iceland (Arnason, 2007).

The above overview shows that each of the Nordic countries has taken a somewhat different approach to adaptation policy and implementation, which reflects differences in countries' political planning and decision-making processes, as well as different senses of urgency (Juhola et al., 2011). The key players in Finland's strategy are national sectoral authorities, whilst the Danish strategy limits the government's role to facilitating autonomous adaptation by other stakeholders. Both Sweden and Norway prioritise local adaptation action on the basis of vulnerability assessments, whilst Finland relied on national climate scenarios and models to identify adaptation needs. In each country there are barriers to the traditional environmental-policy model based on scientific information and political resolve; due to the multi-level nature of adaptation, the traditional model does not appear sufficient to facilitate adaptation action by all relevant public and private stakeholders.

3. The rationale for actor-oriented adaptation research

The research activities summarised in Section 2.1 have all aimed to inform adaptation action in the Nordic countries, but despite the substantial scientific knowledge base developed over the past ten years, adaptation research appears to have had little impact on adaptation action (i.e., planning, policy development and implementation), as also observed by O'Brien (2013). Adaptation researchers have failed to demonstrate to stakeholders the relevance of their findings, forcing stakeholders to base their views and decisions on other kinds of information. The first international conference ' Climate Adaptation in the Nordic Countries: Science, Practice, Policy' (Stockholm, 8–10 November 2010) confirmed that a gap exists between adaptation research and action at all spatial levels within the Nordic region, affecting public and private stakeholders alike.

This gap is perhaps most apparent in how climate change data and information fails to inform policymaking. A study in Norway using vulnerability indicators found that municipal officers requested topographically more detailed scenario data and better local specificity on sector activities than what was available (Næss et al., 2006). Misunderstandings can also arise out of the use of vulnerability maps when complex information is aggregated and visualised in a simple manner (Juhola et al., 2012). In Norway, vulnerability maps failed to communicate the existence of multiple possible scenarios of the future, and were instead interpreted as a single likely future outcome (Næss et al., 2006).

A study of two municipalities in Sweden reveals a gap in communication between those who produce the knowledge and those who use it. In planning for adaptation, there were consistent misunderstandings between the national authorities and the local planners related to the worst-case scenario. It was unclear to many engaged in the process whether the worst-case scenario included climate scenarios or whether it was based on knowledge of climate variations over the last 100 years (Storbjörk, 2007). Even when climate information is available to local-level decision-makers, as is the case in Finland, they face the task of choosing the most relevant information to them, which can be a time-consuming task (Juhola, 2010), and other responsibilities compete for the same time (Westerhoff and Juhola, 2010).

Collectively the above-cited and other literature (e.g., Biesbroek et al., 2010; O'Brien, 2013) suggests the existence of at least five bottlenecks to the use of adaptation research in policy and decision-making:

- Theoretical concepts and constructs developed and applied in adaptation research do not relate to the decision ' reality' of stakeholders;
- Uncertainty surrounding the potential impacts of climate change makes stakeholders inclined to wait and see rather than act;

- There is a mismatch between the local scale on which many stakeholders operate and the smaller-scale climate information provided by models;
- There is a mismatch between stakeholders' primary concern to manage current climate variability, and the medium- to long-term perspective of much adaptation research;
- Adaptation research often ignores the fact that adaptation is not the only priority for many stakeholders.

Much adaptation research builds on a conceptual foundation developed in the 1990s and summarised by Smit et al. (1999, 2000) and Füssel and Klein (2006). These seminal papers developed a typology of adaptation (e.g., autonomous vs. planned adaptation, anticipatory vs. reactive adaptation), outlined key questions to be considered as part of an adaptation assessment (adaptation to what? who or what adapts? how does adaptation occur? how good is the adaptation?), and showed how key concepts such as exposure, vulnerability, impacts and adaptive capacity relate to one another. Whilst this foundation has been useful and influential in structuring academic discourse and international policy on climate adaptation, it does not consider the strategic and operational levels at which stakeholders make actual adaptation decisions, nor that adaptation is a messy process rather than a linear one. In other words, adaptation research has long been about classifying options to reduce projected impacts rather than about the process by which adaptation decisions are made. In addition, to many stakeholders adaptation concepts developed and applied by academics appear overly theoretical and irrelevant to their day-to-day reality. This even concerns the very use of the word ' adaptation', which is not part of most stakeholders' standard vocabulary and is therefore often interpreted as doing something new, rather than doing something better. Some researchers argue that reframing climate adaptation as climate risk management facilitated by organisational learning could help to connect better between adaptation theory and practice (Jones, 2001; Storbjörk, 2007; Pelling et al., 2008).

The projection of climate change impacts is uncertain for two reasons. First, scientists have incomplete understanding of the way in which natural and social system dynamics affect climate change and climate impacts, which means that these dynamics cannot be captured fully within any kind of model. Second, it is impossible to predict with accuracy future demographic, technological and economic change, which will influence both greenhouse gas emissions (and thereby the level of climate change) and the emergence or reduction of people's vulnerability to the impacts of climate change. Whilst scientific progress will continue to yield better understanding of system dynamics, uncertainty will never disappear, and stakeholders will always need to consider it in their adaptation decisions (Dessai and Hulme, 2004; Patt and Dessai, 2005; Patt, 2006; Hall, 2007). Many stakeholders would already be used to making decisions in the face of uncertainty – for example, with regard to societal preferences and commodity prices. Yet, the same stakeholders often treat uncertainty on climate change as a reason to postpone decisions.

Much adaptation research still conveys the impression that detailed knowledge of future climate conditions is indispensable for adaptation policy and decision-making. But it is not sufficient merely to supply stakeholders with climate scenarios and other forms of climate information; it must be accompanied by targeted guidance to support its uptake, and there needs to be continuous dialogue to balance user requirements and expectations with the ability of the scientists to produce and deliver knowledge and information (Welp et al., 2006; Gawith et al., 2009; Larsen et al., 2012). Such dialogue would foster awareness that the production of climate information is a complex task that requires making compromises between the needs of science and those of policy (Hulme and Dessai, 2008). Regardless of uncertainty and complexity, however, the spatial resolution of climate projections does not match the scale of many adaptation interventions. Climate science and modelling have made great advances over the past years: over a period of 10–15 years the typical resolution of regional climate models has increased from around 100 km to 25–50 km (e.g., Christensen and Christensen, 2007; Rummukainen, 2010; Kjellström et al., 2011; Déqué et al., 2012). Higher resolutions, of the order of 2–10 km, are currently being explored and tested in climate projections (e.g., Kendon et al., 2012; Walther et al., 2013). Yet it remains difficult to justify investment in adaptation on the basis of climate information alone, in particular on a local scale (Dessai et al., 2005, 2009). This applies especially to adaptation to changes in the frequency, magnitude and spatial occurrence of extreme weather events, such as windstorms, floods and heat waves (IPCC, 2012).

Related to the mismatch in spatial scales is a concurrent mismatch in temporal scales. The focus on adaptation to future climate conditions has distracted from the fact that many communities, firms and households are not well adapted to the current climate. In other words, there is an ' adaptation deficit' (Burton, 2004), which renders people vulnerable to weather-related hazards already now. Stakeholders may or may not be aware of this deficit and how it might affect them, but in many cases a good starting point for adaptation would involve better managing risks associated with today's climate. Burton (2004) argued that adaptation to future climate conditions is less likely to be effective when current adaptation deficits are not also addressed.

Adaptation research often ignores the fact that adaptation is not the only priority for many stakeholders and that adaptation has to compete with many other concerns. A study of two Swedish municipalities showed how economic interests and aesthetic values can conflict with the need for adaptation (Storbjörk 2007). The need of a new embankment as a river flood protection is viewed by some residents as unnecessary and compromising the quality of their living space. Similarly, investments are allowed onto flood-prone areas in the order to improve the economic development of a locality, despite the risk to flooding (Næss et al., 2005).

Although often repeated, the suggestion that mitigation is a global issue whilst adaptation is a local one presents a false and unhelpful dichotomy (Adger, 2001; Pielke et al., 2007; Burton, 2011). As Aall (2012) pointed out, mitigation has a longer and stronger tradition than adaptation in many municipalities. Langlais (2009) concluded that the distinction between mitigation and adaptation has become obsolete at the local level: he coined the term ' adaptigation' to signal that many local decisions have an effect on both mitigation and adaptation, and that mitigation efforts influence adaptation and vice versa. As a result of the latter type of interaction, decision-makers could be seen as adapting not only to the adverse effects of climate change but also to the consequences of climate policy.

4. A framework for actor-oriented adaptation research

4.1. Applying actor-oriented theory to adaptation research

The above insights raise questions about the value of current adaptation theory in understanding the process through which adaptation is negotiated, facilitated and implemented. Not only does a great deal of adaptation research appear to be detached from the reality of stakeholders, but often the research emphasises scenarios and relative vulnerabilities, rather than specific options or practical alternatives (Smit and Wandel, 2006; Arnell, 2010; Eisenack and Stecker, 2012). Hence, much of the adaptation literature stresses systems over actors and processes over actions – again, failing to consider stakeholders and the contexts within which they operate.

The disconnect between adaptation research and adaptation action has arisen because the predominant framing of adaptation does not adequately consider the notion of agency, as also recognised by others (Eisenack and Stecker, 2012). This disconnect is, of course, not new and has also been described and analysed in other fields of environmental decision-making. Keeley and Scoones (2003) identified the contributions that an actor-oriented approach can make in understanding the links between science and policy, and how environmental policy processes unfold.

In conceptualising the link between science and policy, actor-oriented theory rejects the more structural approaches to understanding policy processes based on an analysis of formal institutions alone. Instead, it emphasises the role of individuals and groups in creating and maintaining socially embedded networks (Keeley and Scoones, 2003). Actor-oriented approaches to understanding social phenomena draw from the works on practice and agency, for example by Latour (1999), emphasising the role of the actor, or stakeholder, in negotiating social reality. Although the actors themselves are embedded in networks and societal settings, their actions are based on the possibility of choice when negotiating these structures. This exercise of agency through repeated practice can create both intended and unintended consequences that lead to policy change.

Actor-oriented theory envisions the creation of scientific knowledge as a process in which both scientists and non-scientists take part. As the production of knowledge and the practice of science co-evolve with political decision-making, scientists, policy entrepreneurs and other actors are brought together into epistemic communities (Haas, 1992). This does not mean that new research findings are always translated into action: it may still take a triggering event (Kingdon, 1984), or what Birkland (2006) called a ' focusing' event. However, closer links between science and policy increase the likelihood of action (Westerhoff and Juhola, 2010).

Actor-oriented theory can be particularly helpful in shedding light on how knowledge emerges and spreads, as it distinguishes between categories of actors, such as the state, civil society, community and the scientific establishment (Keeley and Scoones 2003). When applied to climate adaptation, actor-oriented theory enables one to examine the role of scientific knowledge in framing the understanding of adaptation and in identifying policy options derived from that understanding. These options are then taken up by actors and the respective understanding of adaptation is upheld through practice.

4.1.1. Methodological approaches

The second of the aforementioned bottlenecks, on the uncertainty surrounding the potential impacts of climate change, and the third bottleneck, the mismatch between climate information provided and the scale at which stakeholders operate, are associated with the way in which climate information is produced and how uncertainty is communicated. Hence, one challenge for adaptation research is to develop new methodological approaches that connect relevant developments and insights in climate science with ways in which stakeholders can adopt and apply such knowledge in practice.

Innovative methodological approaches to modelling and visualisation provide new opportunities for adaptation research, by translating climate information and other scientific knowledge into suitable formats and by making climate change and adaptation explicit to stakeholders (Sheppard et al., 2011; Nicholson-Cole, 2005). Climate visualisation refers to interactive research platforms that use computer graphics to illustrate causes and effects of climate change, as well as the effect of potential mitigation and adaptation options (Johansson et al., 2010). Examples of downscaling climate data and visualisation exist already, including charts, maps and three-dimensional models and graphics (Dockerty et al., 2005).

Visualisation tools aim to engage stakeholders and can contribute to social learning (Sheppard, 2005), although the effectiveness of visualisation on decision-making is still an under-researched area, and there may be ethical issues involved in the use of visualisation tools (Nicholson-Cole, 2005). Controlled experiments on how uncertainties and variations in data are conveyed could further improve visualisation tools, as could qualitative evaluations of the usefulness of these tools in controlled experiments or case studies in realistic settings (Johansson et al., 2010).

As suggested by the fourth and fifth of the above bottlenecks, the availability of more relevant information does not mean that adaptation decisions will be made or action will automatically follow. Much adaptation research takes a long-term perspective, focusing on slow-onset impacts of climate change, whereas many actors have more immediate interests, including planning and implementing measures to adapt to current climate variability. Moreover, adaptation research often considers only climate impacts as the possible trigger for action, with little connection to other, perhaps more pressing, local issues.

To make adaptation research more relevant, the task ahead is to develop research methodologies that acknowledge the complex reality within which climate change is happening and decisions are made, whilst producing pragmatic results upon which stakeholders can act. Socio-economic, demographic, institutional, legal, organisational and cultural aspects that shape adaptation policy and decision-making need to be taken into account when designing and conducting research for adaptation (Moser, 2010). Disciplines such as political science, sociology, psychology, economics and geography can therefore make valuable contributions to adaptation research, in particular to analysing the emergence and use of adaptive capacity.

Efforts to enhance the value of adaptation research could also build on existing policy-analytical approaches. For example, an analysis of the use of the strategic environmental assessment (SEA) in Denmark revealed that positive or negative synergies between climate adaptation and mitigation, and between adaptation and other policy areas, are often not considered (Larsen et al., 2012). It is also possible to adopt and apply new social-scientific methods aimed at understanding how stakeholders make decisions and how best to support those decisions. The use of games in decision-making analysis, for example, is an emerging area of research (Patt et al., 2010).

4.1.2. Adaptation issues

Methodological approaches to adaptation research based on actor-oriented theory should be applicable to any issue of concern to stakeholders. In the Nordic countries, land use for primary production, such as agriculture and forestry, is of great economic interest, as is urban land development. Agriculture, forestry and urban development are affected both by the impacts of climate change and by the impacts of climate policy. Changes in mean temperature and precipitation as well as changes in weather extremes are likely to affect agriculture (Olesen and Bindi, 2002; Olesen et al., 2011) and forestry (Bergh et al., 2003; Maracchi et al., 2005; Poudel et al., 2011). Urban development will have to adapt primarily to expected changes in extremes, a process now often referred to as ' climate-proofing' the built environment (Rasmussen et al., 2010).

In addition to climate change, climate policy (as well as other policies) affects decisions related to land use. For example, EU and national policies and legislation are promoting the use of biomass in energy production (Ericsson et al., 2004; Stupak et al., 2007). In the urban context, climate policy and the need to reduce greenhouse gas emissions influence urban planning, for example with respect to building density (Biesbroek et al., 2009).

The energy systems of the Nordic countries are diverse and based on a variety of energy sources, including nuclear, hydropower and other renewables, and these systems are also linked, for example, within the Nordic Energy Market. Energy systems can be susceptible to the impacts of climate change both in terms of supply and demand (Mideksa and Kallbekken, 2010; Schaeffer et al., 2012). Recent storm events in the Nordic countries, such as the 2011 Boxing Day storm that left hundreds of thousands of people without electricity for weeks, have highlighted the vulnerability of the electricity system in particular (Pohjanpalo, 2011). Not much is known about the impact of weather events on the supply of renewable energy, although the Finnish Forestry Centre estimates that the 2011 Boxing Day storm felled approximately 3.5 million m^3 of wood in Finland and 4–5 million m^3 in Sweden (Merivuori, 2012). A study of the impacts of the 2005 storm Gudrun, which felled approximately 75 million m^3 of forest, noted that storms lead to an initial surge in supply of biomass, followed by a significant drop in the longer term (Björheden, 2007).

Nordic energy systems are also impacted by the goals of climate and energy policy set by, for example, the EU's Climate and Energy Package (Commission of European Communities, 2007). This Package includes renewable energy; biomass is a particularly important source of energy in Finland and Sweden (Ericsson et al., 2004; Kautto et al., 2012). The implementation of policies to achieve these goals is left to the individual countries, creating a variety of approaches in the Nordic region (Christiansen, 2002; Björheden, 2006; Lund, 2007; Pettersson et al., 2010; Valkila and Saari, 2010; Sperling et al., 2011).

Although the vulnerability of the Nordic countries is considered to be low, impacts of climate change could still result in significant economic losses and have other fiscal implications, such as public spending on adaptation and mitigation (Osberghaus and Reif, 2010). In terms of direct costs, the insured losses of the storm Gudrun, for example, were estimated to be around SEK 3 billion in Sweden, DKK 3.5 billion in Denmark and EUR 5 million in Finland (Guy Carpenter, 2005). Insurance and finance can constitute an important instrument in adaptation policy, thus forming an important part of the adaptive capacity of societies to spread climate-related risk. At the same time, however, the availability of insurance and finance could lead to investment and other behaviour that increases exposure to climate change.

Similarly, the performance of the insurance and finance industry is also influenced by climate policy. The success of mitigation, aimed at reducing the risk of reaching dangerous levels of climate change, matters to the industry as it affects the need to cover insured costs associated with climate impacts and to invest in adaptation.

4.2. Applying methodological approaches to adaptation issues

An actor-oriented approach to adaptation research also requires one to re-examine how adaptation is conceptualised. There are many definitions of adaptation to climate change (Smit and Wandel, 2006); a widely used one, proposed by the IPCC (2007), emphasises the systemic nature of adaptation rather than considering adaptation as a process that involves action taken by specific actors (see also Eisenack and Stecker, 2012). In analysing the evolution of vulnerability and adaptation assessments, Füssel and Klein (2006) noted that over time, these assessments have increasingly included or even highlighted non-climatic factors. However, most assessments continued to take a systemic view of adaptation and lacked the explicit consideration of agency.

This paper argues that there is a need to be explicit about and to further clarify the role of actors or stakeholders in the adaptation process, as well as about all climatic and non-climatic factors that influence their actions. Figure 1 is based on Füssel and Klein (2006); they used it to illustrate the evolution of impact, vulnerability and adaptation assessments. Building on the IPCC conceptualisation of vulnerability (as a function of exposure, sensitivity and adaptive capacity), Füssel and Klein (2006) explained influence relationships amongst relevant concepts; included non-climatic factors as an explicit determinant of exposure, sensitivity and adaptive capacity; and showed the various pathways in which adaptation and mitigation can modify impacts and vulnerability. In addition, they distinguished between facilitating and implementing adaptation and mitigation. Facilitation refers to any efforts that increase adaptive or mitigative capacity, which in turn enables the actual implementation of adaptation or mitigation actions.

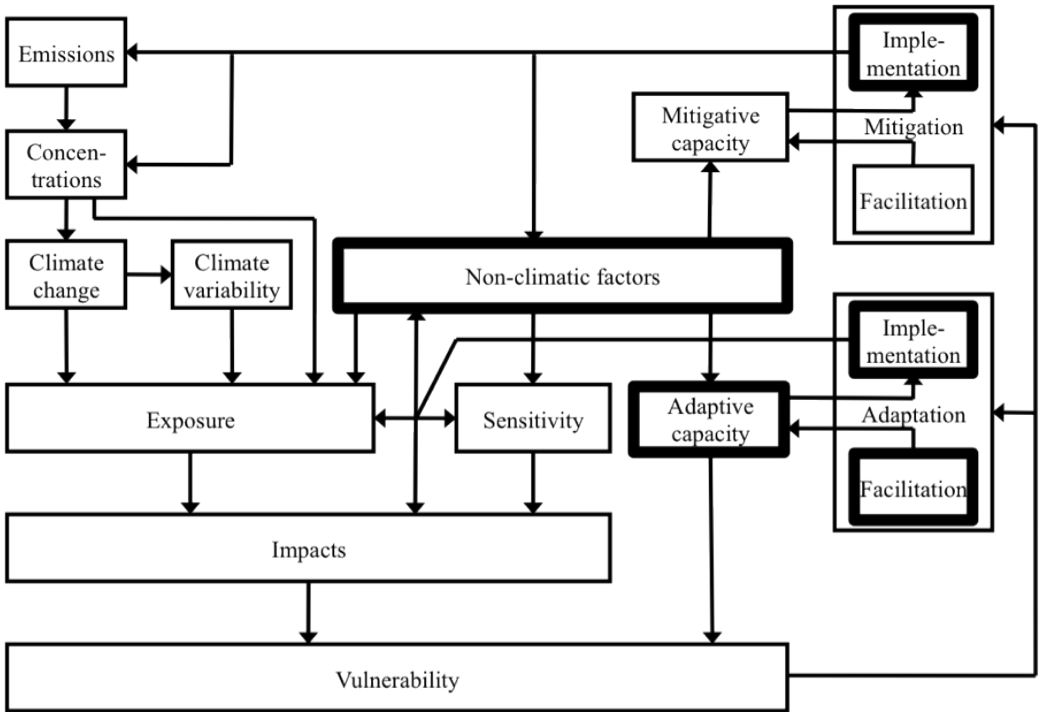

Figure 1: A framework for assessing climate change impacts, vulnerability and adaptation, adapted from Füssel and Klein (2006). The bold boxes are elements of the framework that are identified for further elaboration in the action-oriented approach to adaptation research proposed in this paper.

A limitation of the presentation by Füssel and Klein (2006) is that it does not include agency: the systemic approach they describe does not take account of who could act to facilitate or implement adaptation and mitigation, or whose adaptive and mitigative capacity could be strengthened or used. In taking an actor-oriented

approach to adaptation research, it is particularly important to be explicit about agency when analysing adaptive capacity, how it is influenced by facilitative efforts, and how it underpins the implementation of adaptation action. This elaboration on the framework by Füssel and Klein (2006) is denoted by the three bold boxes at the bottom right of Figure 1.

A second elaboration on the framework is the influence relationship between the implementation of mitigation and non-climatic factors. The arrow between the upper two bold boxes in Figure 1 signifies that the mitigation of climate change could affect non-climatic factors in such a way that it has knock-on effects on exposure, sensitivity or adaptive capacity. Mitigation of climate change could thus influence vulnerability and, in turn, the need for adaptation. For example, the increased use of biomass for fuel production could lead to a change in commodity prices to which farmers would adapt by changing their crops. More indirectly, these changing commodity prices could affect the affordability and availability of food, possibly rendering more people vulnerable to malnutrition and thus requiring adaptation aimed at safeguarding food security. Policymakers setting targets for the production of biofuel, farmers adapting to immediate price signals, and those involved in safeguarding food security are very different actors in the adaptation process. If adaptation research is to be effective in informing adaptation action, the roles and responsibilities of these and other actors need to be analysed, and the consequences of climate policy must be considered along with the impacts of climate change.

Taking an actor-oriented approach that considers the dual impacts of climate change and climate policy leads to new research questions. Regarding land use, for example, how does climate policy influence actors' decisions, and how does it affect their capacity to adapt to impacts of climate change? In addition, research could address trade-offs in land management and land-use planning that may arise between adaptation and mitigation. Questions about energy transitions, meanwhile, might need to be framed to include measures to enhance adaptive capacity and reduce vulnerability to climate impacts. Such a framing would acknowledge the need for low-carbon energy systems to also contribute to adaptive capacity, and the possibility that such systems are vulnerable to the impacts of climate change.

4.3. Applying the framework for actor-oriented research in the Nordic region: NORD-STAR

Actor-oriented adaptation research should advance knowledge on the process of adaptation and the role of actors in the Nordic countries. It should provide new insights into what makes actors take adaptation action and what keeps them from acting, thus creating knowledge that could help to overcome the bottlenecks discussed in Section 3. Figure 2 presents a research matrix designed for this purpose. The matrix combines the methodological innovations in visualisation and modelling and in policy analysis with the adaptation issues relevant to the Nordic countries. It now underpins a new adaptation research effort, the Nordic Centre of Excellence for Strategic Adaptation Research (NORD-STAR), core-funded by the Norden Top-level Research Initiative.

Figure 2 shows that the overlay of the methodological approaches with the adaptation issues creates six individual research projects, each with specific questions. In addition, the matrix provides both vertical and horizontal integration possibilities. For example, by addressing both the production of climate information and its role in policy and decision-making in land use, it is possible to better understand the process of adaptation decision-making and provide more stakeholder-relevant information. In addition, horizontal collaboration across different thematic issues enables a discussion on methodological issues that are necessary to ensure rigour and scientific development of the field.

Collectively, the projects defined by the NORD-STAR research matrix aim to address two overarching research questions:

* What new challenges and opportunities emerge when developing a strategy to adapt to both the impacts of climate change and the consequences of climate policy?
* How can dialogue and innovation help to advance strategic adaptation action in the Nordic region?

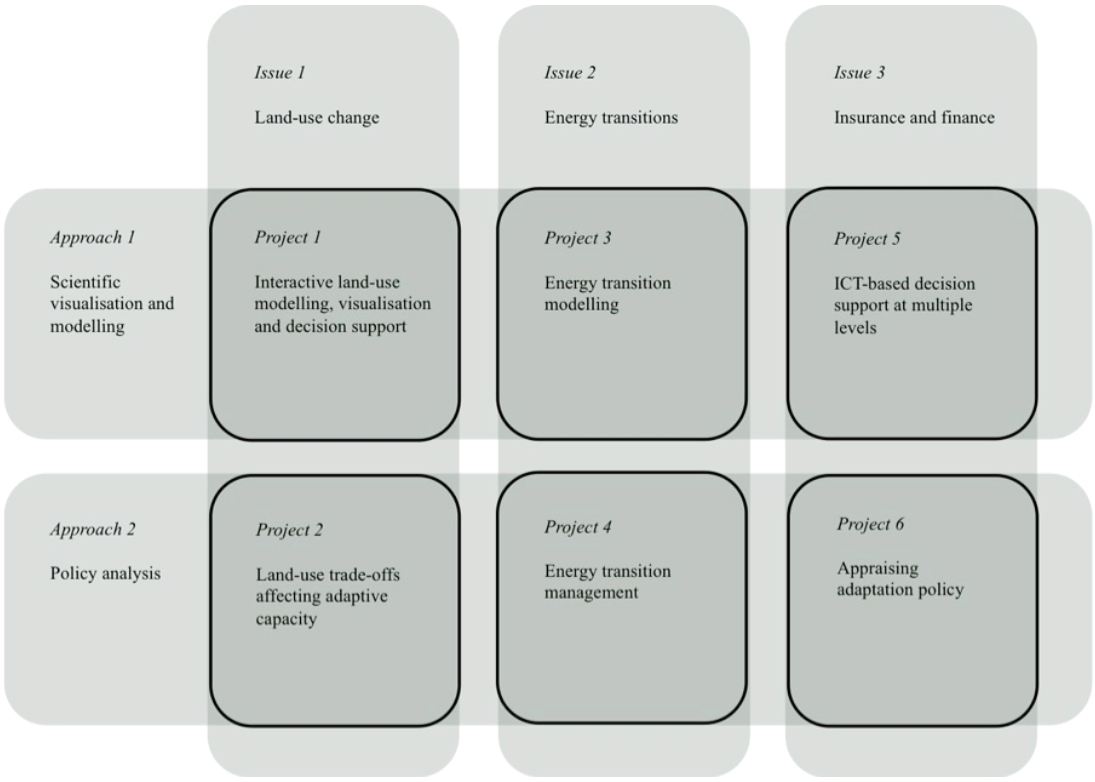

Figure 2: The NORD-STAR research matrix.

The framework for actor-oriented research proposed here thus combines the systemic framework by Füssel and Klein (2006) with two novel developments: the use of theory and methods aimed at bridging the gap between adaptation research and action, and the framing of adaptation as addressing both the impacts of climate change and the consequences of climate policy. The application of this framework within NORD-STAR and elsewhere will need to consider the expanding landscape of adaptation actors, with new actors emerging to facilitate and implement adaptation action. To take adaptation action used to be seen as the responsibility of national governments (Klein, 2011), but research in the Nordic countries and elsewhere has shown that local-level practitioners, private decision-makers, consultants as well as researchers all have important roles to play.

5. Conclusions

The proliferation of adaptation research in the past ten years has not automatically resulted in the uptake of research results into adaptation policy and practice. This is particularly the case in the Nordic countries, which have been at the forefront of adaptation research but have been slow in implementing adaptation activities. This paper identifies five bottlenecks, related to the framing of adaptation and methodological issues, which have contributed to the current gap between adaptation research and action. Advocating an actor-oriented approach to adaptation research, this paper frames adaptation as a response both to climate change impacts and to the consequences of climate policy, better reflecting the decision-making realities of stakeholders.

In addition to including agency in the analysis of adaptation policy and practice, the research framework proposed in this paper emphasises the facilitative role of adaptation research. Adaptation research contributes to adaptive capacity and thus supports the planning and implementation of adaptation action. The framework stresses the importance of co-producing knowledge by both scientists and practitioners, thus arguing that adaptation researchers are part of the adaptation process and actively frame the adaptation agenda.

An actor-oriented approach to adaptation research enables researchers to address questions that are often neglected when taking a traditional, systemic perspective of adaptation that does not consider the role of agency. As the implementation of adaptation progresses slowly at national and local levels, questions emerge not only about the effectiveness of adaptation policy and decision-making, but also about that of adaptation research itself.

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