Adaptation to Climate Change: Understanding the Contingent Nature of Spatial Vulnerability Assessments

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Lynn Rosentrater
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CONTENTS

ABSTRACT

Climate change affects people and places differentially and vulnerability is the primary means by which to understand how climate interacts with local contexts. Assessing vulnerability characterizes climate-related impacts and the mechanisms that facilitate coping responses. The papers in this dissertation show that different forms of knowledge and knowledge seeking affect how vulnerability is understood and thus managed through adaptation. Drawing on geographic research traditions associated with environmental geography, behavioral geography, vulnerability science and geographic information science, I critically examine information associated with vulnerability assessments and demonstrate that the concept of vulnerability not only encompasses the negative material outcomes associated with climate change, but also how those outcomes are differentially perceived and valued. Abstract, scenario-based information alone does not motivate adaptive action because diverse problem understandings lead to different priorities about how to respond to climate change, including biases toward complacency and inaction. Heuristic engagements between adaptation actors that consider the ways in which people experience and respond to change in practice lead to deeper understandings of vulnerability that reveal multiple entry points for adaptation. A framework to support analytic-deliberative decision-making in the contested space between ephemeral and measureable knowledge, where several interpretations of vulnerability can be valid at the same time, is presented. The lessons learned here are relevant even as the IPCC shifts its focus from vulnerability to risk.

PAPERS IN THIS DISSERTATION

I. Rosentrater, L.D. (2010) Representing and using scenarios for responding to climate change. *Wiley Interdisciplinary Reviews-Climate Change,* 1(2): 253-259.

II. Rosentrater, L.D., I. Sælensminde, F. Ekström, G. Böhm, A. Bostrom, D. Hanss & R.E. O'Connor (2013) Efficacy Trade-Offs in Individuals' Support for Climate Change Policies. *Environment and Behavior,* 45(8): 935-970.

III. Rosentrater, L.D. (submitted) Assessing vulnerability to climate change: What (and who) is missing? *Regional Environmental Change*.

IV. Rosentrater, L.D. and K. O'Brien (submitted) What's the problem? The contingent nature of vulnerability in spatial planning for climate change adaptation in Norway. *Environment and Planning A*.

V. Rosentrater, L.D. (2015) Integral GIS: Widening the Frame of Reference for Adaptation Planning. In: K. O'Brien and E. Selboe (eds), *The Adaptive Challenge of Climate Change*. Cambridge: Cambridge University Press.

Other publications co-authored by the candidate as part of her course of study include:

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Carter, T., S. Fronzek, A. Inkinen, I. Lahtinen, H. Mela, K. O'Brien, L. Rosentrater, R. Ruuhela, L. Simonsson & E. Terämä (2016) Characterising vulnerability of the elderly to climate change in the Nordic region. *Regional Environmental Change,* 16(1): 43-58.

PROVIA. (2013) PROVIA Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change. Nairobi, Kenya: United Nations Environment Programme, 174 pp.

INTRODUCTION

Climate change is a global problem with significant impacts on local communities. Cities and towns around the world increasingly experience extreme weather events that cause widespread damage and serious disruption to the normal functioning of daily life. Severe storms damage infrastructure and impair critical systems for transportation, communication and energy; dry weather reduces local water supplies and increases fire risk; and periods of prolonged heat create public health risks, especially for elderly, young and disadvantaged citizens. Scientific evidence suggests that climate change is influencing and will exacerbate the frequency and intensity of extreme events, leading to a general increase in vulnerability and potential losses (IPCC 2012). Preparing for the consequences of climate change through planned adaptation is therefore an imperative for local governments.

Adaptation takes place in response to observed or expected changes in climate and climate variability — which includes the frequency and intensity of extreme events — through actions that reduce vulnerability to climate-related impacts (Smit et al. 2000). Many adaptation processes use geographic information systems (GIS) to ground their analyses in spatially nuanced evaluations of risk (Preston et al. 2011b). GIS consists of a set of practices that operate across various scales (i.e., geographic, temporal and governance) to address spatial problems (Schuurman 2004), and is widely used by local governments for planning and management because it provides a formal framework for working with stakeholders to facilitate inclusive decision-making (Craig et al. 2002; McCall and Dunn 2012). A diverse assembly of interested parties, each with their own values and agendas, participates in adaptation planning by deliberating over the harmful or unwanted consequences of climate change. These discussions are informed by vulnerability assessments that describe how climate is projected to change and how those changes may affect people and places.

Vulnerability assessments are key to understanding the consequences of climate change on social and natural systems. The premise of assessing vulnerability is to understand the potential harm that may result from the effects of climate variability and change (Adger 2006; IPCC 2014). Vulnerability is a relative condition determined by the biophysical and social processes that describe local circumstances, which makes it particularly well suited to spatial representations (Preston et al. 2011b). Vulnerability maps are accessible and powerful devices that communicate climate-related risks for some geographic extent, i.e., a region, city or neighborhood. Methods for mapping vulnerability are dominated by indicator-based approaches that serve policy-makers' needs for simple, generalized, and actionable information (Füssel 2009). However, vulnerability is a subjective concept that has as much to do with how people perceive themselves in relation to climate change as it does to the potential for harm (O'Brien and Wolf 2010). Despite the existence of numerous methodological guidelines, spatial vulnerability assessments are still largely characterized by experimentation (Preston et al. 2011b). Most frameworks are based on objective (i.e., externally measureable) variables that quantify material outcomes without taking into account the non-material concerns (e.g., identity, beliefs and values) that are important to stakeholders (Turner et al. 2008); the absence of such subjective evaluations in vulnerability assessments may account for the limited evidence of adaptation action that has been observed to date (Preston et al. 2011a; Tompkins et al. 2010; Ford et al. 2011).

The effect of GIS on objects of its scrutiny has been passionately debated in geography since the early 1990s (Schuurman 2000). Two seminal collections — John Pickles's *Ground Truth* (1995) and a special issue of *Cartography and Geographic Information Systems* edited by Eric Sheppard (1995) — summarize the unease with which human geographers viewed GIS in the years that followed geography's quantitative revolution. The period was marked by "science wars," which consisted of a series of intellectual exchanges between scientific realists and social constructivists regarding the "epistemological privilege enjoyed by

science and the degree to which science is culturally influenced" (Schuurman 2000: 571). Within the discipline of geography, constructivists argued that GIS was inattentive to theoretical advances in human geography, especially those having to do with non-visual representations and the dynamics of power. At the time, GIS followed conventions rooted in logical positivism and Cartesian geometry, and critical geographers were concerned that GIS was being used to reinforce top-down, expert analyses of geographic problems in a way that limited how those problems could be represented and subsequently addressed through policy (Schuurman 2000).

In the intervening years, critical GIScience has responded to concerns about the social, political and epistemological implications of GIS by developing new approaches drawn from qualitative research methods that include novel techniques for representing multiple realities of single issues (Elwood 2010). The consequence for GIS praxis is an acceptance that each unique ontological interpretation of space will also result in a different epistemology (Eddy 2008). This recognition of multiple ontologies links GIS to the plurality of climate change (Hulme 2009; Esbjörn-Hargens 2010; O'Brien 2009). The notion that climate change has a different echo depending on individuals' personal beliefs, worldviews and direct experience, provides the foundation for this study of the contingent nature of spatial vulnerability assessments.

STUDY AIM AND RESEARCH QUESTIONS

Climate change is just one of many types of shocks and stressors that local communities face (Wilbanks and Kates 2010). In order to understand the risks — and in some cases opportunities — that climate change poses, local decision-makers need information about impacts and vulnerability in order to plan appropriate responses. The aim of this dissertation is therefore to critically examine spatially referenced information about climate change impacts and vulnerability for the explicit purpose of adaptation

planning. Four research questions guide this exploration:

1. What are the potentials of and limits to using climate scenarios in adaptation planning?
2. How do people understand climate change and perceive the effectiveness of different responses?
3. Why do many vulnerability assessments fail to engage stakeholders?
4. What methods can be used to integrate and represent qualitative, contextual information with quantitative, scenario-based data?

BACKGROUND AND CONTEXT

This dissertation took shape within a large, interdisciplinary project that conceptualized adaptation as a social process that is likely to be limited by differential interests, values, beliefs, priorities and power relations, all of which are factors that may themselves change in response to ongoing societal transformations (O'Brien 2009). The overarching project[1] combined empirical, place-based research on adaptation with analysis of planning processes and institutional reforms that together contextualize the potentials of and limits to adaptation in Norway (O'Brien and Selboe 2015). The project took place from 2007 to 2012 during a period of intense activity across the landscape of Norwegian climate research.

In 2008, the government commissioned an official public report[2] on Norway's vulnerability and the need to adapt to the impacts of climate change. The report was submitted to the Ministry of the Environment two years later (NOU 2010) and shows that average annual precipitation is expected to increase up to 30 % by 2100 with major seasonal and regional variations (Hanssen-Bauer et al. 2009). There will also be an increase in the number of days with heavy precipitation, and the average rainfall on those days will be higher throughout the entire country during all seasons. A two to three month reduction in the snow season is expected by the end of the century due to higher temperatures.

[1] PLAN, see www.sv.uio.no/iss/english/research/projects/plan/
[2] Referred to in the local language as an NOU for *Norges offentlige utredninger*.

Average annual temperature is expected to increase by 2.3 to 4.6 °C, with the greatest warming expected in northern Norway during the winter months. In addition to the overall warming trend, there will be an increased number of days with extreme temperatures, which are defined as a daily mean above 20 °C (Hanssen-Bauer et al. 2009).

Changes in temperature, precipitation and extreme weather will have consequences on Norwegian nature and society (NOU 2010). A loss of biodiversity is expected in northern Norway and at high altitudes, since those areas have the highest projected rates of change and consist of habitats that are already marginal. Physical infrastructure, building assets and related facilities will be exposed to increasingly extreme weather as time goes by. Specific vulnerabilities vary by sector, but insufficient maintenance is seen as a common challenge that will be amplified by climate change (*cf.* chapter 9 in NOU 2010). New opportunities for economic growth are projected within the primary industries and the energy, shipping and tourism sectors, although the potential for maladaptation is high.[3] The report notes that autonomous adaptations in response to anticipated events will be insufficient to ensure a resilient society in the future, therefore, preventive long-term adaptation initiatives must be developed. Despite scientific uncertainty regarding the timing and magnitude of climate change, the NOU states clearly that "we know enough to conclude that efforts to adapt must be introduced immediately" (NOU 2010: 16).

It is the Norwegian government's official position that climate adaptation should not be separated from other planning processes (KLD 2014). This requires that the local authorities responsible for a particular area of society (i.e., health and safety, business and industry, physical planning, or natural resource management, etc.) must also be manage the impacts of climate change by integrating climate considerations into their regular planning and decision-making processes. The government's adaptation strategy is thus to

[3] Actions can be maladaptive if they increase vulnerability (McCarthy et al. 2001). For example short-term economic gains from oil and natural gas production as a result of an ice-free Arctic can be regarded as a maladaptation because it creates a positive feedback by increasing greenhouse gas emissions in the long-term.

mainstream climate change into existing spatial planning and emergency management. The two primary instruments called upon to enable mainstreaming are the Planning and Building Act[4] of 2009 and the Civil Protection Act[5] of 2010. The Planning and Building Act provides the framework for all land-use planning in Norway. The basic tenet of the law is to advance a long-term perspective in public planning[6] based on the precautionary principle[7] with the normative goal of sustainable development. The Civil Protection Act is designed to protect health and safety, physical assets and critical infrastructure in adverse situations. Risk and vulnerability assessments are highlighted in both laws, but with slightly different emphases: the Planning and Building Act regulates risks and vulnerabilities associated with natural hazards and the Civil Protection Act addresses risks and vulnerabilities in the context of emergency management. These assessments are intended to identify risks and the possible consequences of those risks, thereby providing the basis for planning preventive measures. The Norwegian Directorate for Civil Protection and county governor (*fylkesmannen*) recommend using GIS to meet statutory requirements for assessing vulnerability to climate change (DSB 2015).

RESEARCH SCOPE

This dissertation — grounded in human geography, with its emphasis on human-environment relationships, scale, and place-based studies — combines research traditions in environmental geography, behavioral geography, vulnerability science and geographic information science (GIScience). I have approached my research questions with methodological pluralism and used induction to draw conclusions about how spatial information can be communicated in a manner that facilitates responses to climate change. Data collection was conducted in Norway, an affluent country that is highly exposed to

[4] Plan- og bygningsloven, see www.lovdata.no/lov/2008-06-27-71
[5] Sivilbeskyttelsesloven, see www.lovdata.no/lov/2010-06-25-45
[6] Ot.prp. nr. 32 (2007-2008), see www.regjeringen.no/nb/dokumenter/otprp-nr-32-2007-2008-/id500508/
[7] Meld. St. 33 (2012–2013), see www.regjeringen.no/nb/dokumenter/meld-st-33-20122013/id725930/

climate change and at the same time considered resilient to negative impacts (O'Brien et al. 2004). Developed countries[8] have extensive access to financial and technical resources and often have a strong institutional base from which adaptation can occur. Studying experiences in a country like Norway can therefore highlight the structures, relationships and processes that mobilize (or limit) adaptation, insights that are valuable for developed and developing countries alike.

My research process included a three-month visit to the National Center for Atmospheric Research in Boulder, Colorado to work with scholars in their GIS program.[9] The focus of my time there was twofold: 1) professional development in the integration of natural and social sciences data in GIS, and 2) assessment strategies for extreme heat vulnerability (i.e., Wilhelmi and Hayden 2010). I was also a guest at the Finnish Environment Institute (SYKE) where I contributed to the design and implementation of a vulnerability assessment in the Nordic region.

At the heart of this dissertation is the evaluation of a GIS-based tool – called CARAVAN – developed to characterize vulnerability of the elderly to climate change in the Nordic region. For most countries in Europe the current burden of cold-related mortality is greater than the burden of heat mortality (Analitis et al. 2008). However, certain population groups are also vulnerable to heat-related events; Rocklöv and Forsberg (2010) and Åström et al. (2013) discuss these challenges in the context of northern Europe. The two-year study I participated in with Finnish and Swedish collaborators assessed the vulnerability of Nordic populations aged 65 and older to extreme weather conditions that included heat-related events, cold-related events and exposure to freeze-thaw conditions (Carter et al. 2016). The aim of the project was to provide national and regional officials responsible for the care and welfare of the elderly with an interactive screening tool to

[8] Developed countries are defined here as parties listed under Annex I of the United Nations Framework Convention on Climate Change (UNFCCC).

[9] See www.gis.ucar.edu/about

identify vulnerability hotspots that could warrant further investigation. A map application was developed with an interface that allows users to select from a fixed set of indicators and weigh them according the user's knowledge and judgment about the determinants of vulnerability (Figure 1). My post hoc evaluation of the tool and how stakeholders used it demonstrates that vulnerability is the emergent property of discussions about climatic risks that are informed, but not determined by scientific input.

While that case looked at social vulnerability for welfare planning purposes, a second case presented in this dissertation investigated how physical vulnerability is assessed in the context of spatial planning. Statutory requirements in Norway oblige municipalities to conduct vulnerability assessments at different stages of the planning process. These assessments are then used to identify adaptation needs and to evaluate specific interventions. Using the case of urban development in a flood-risk zone in Oslo I show that planners and market actors each perceive climatic vulnerability differently, a discrepancy that is then overlooked in adaptation decisions and leads to fragmentation across institutions and frustration among all actors. That similar effects were found for assessments of both social vulnerability and physical vulnerability lends credence to my hypothesis that vulnerability assessments are contingent upon subjective factors that include individual and collective beliefs, worldviews, motivations and assumptions.

This dissertation is presented as five stand-alone papers that reveal some of the limits and openings for communicating about climate change at the interface between science and policy. The first article looks at the role of scenarios for responding to climate change by identifying a number of limitations associated with downscaled climate projections developed to help decision-makers plan for the future. The second article is an empirical study of how climate change in Norway is perceived, and how those perceptions affect preferences for different policy responses. The third article reviews vulnerability assessment practices in light of three enabling factors that enhance the uptake of

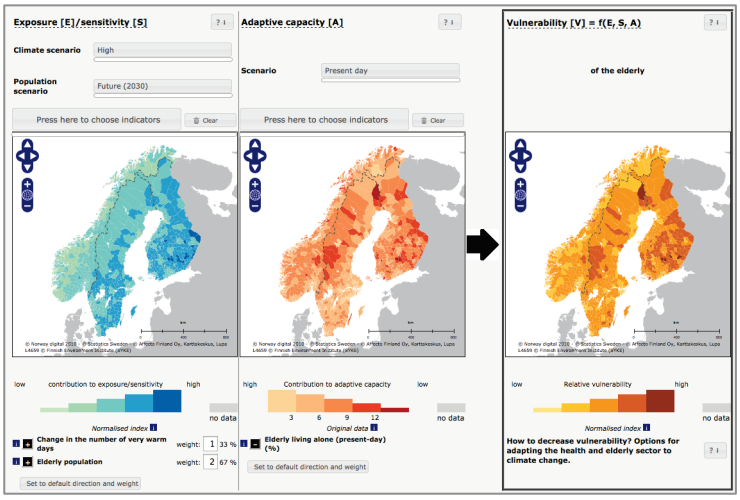

Figure 1: A screenshot of the mapping tool that allows users to select indicators from the available scenarios and map them in their original units, as well as combine them into composite indices of potential impacts, adaptive capacity and vulnerability. The tool is available at www.iav-mapping.net/U-C-IAV/elderly.

assessment results: salience, credibility and legitimacy. Paper four explores how the contingent nature of vulnerability in spatial planning is revealed. The final paper proposes a new assessment approach that recognizes the importance of acknowledging and engaging with a diversity of interests, commitments and values, as well as the politics and power embedded in adaptation planning processes. Together, these papers show that different forms of knowledge and knowledge seeking affect how vulnerability is understood and thus managed.

The dissertation is structured as follows. In the next section I discuss the primary concepts that have shaped my thinking as I conducted this research. I then describe my research design by presenting the theoretical perspectives that underpin the dissertation as well as the methods and data I have employed. After presenting detailed summaries of the dissertation's four papers, I synthesize their findings in a brief discussion. I conclude with a recapitulation of the dissertation and highlight the implications of this work.

FUNDAMENTAL CONCEPTS

The aim of this section is to define the core concepts relevant to this dissertation, the focus of which is assessing vulnerability to climate change for the purpose of identifying adaptation needs. I am particularly interested in how GIS can be used to support analytical and deliberative processes in spatial decision-making. To that end, three fundamental concepts warrant explanation: vulnerability, adaptation, and spatial vulnerability assessment. A fourth term, qualitative GIS, is discussed to frame my overall approach to working with spatial data.

CLIMATE VULNERABILITY

Climate change affects people and places differentially and vulnerability is the primary means by which to understand how climate interacts with local contexts. Vulnerability characterizes climate-related impacts and the mechanisms that facilitate coping responses (Adger 2006). The analysis of climate vulnerability stems from hazards research (Burton et al. 1993) and entitlement theory (Sen 1981) that together can be used to link discrete risks with the social institutions that influence outcomes (Blaikie et al. 1994). The most widely applied interpretation of vulnerability originated in the IPCC's[10] Third Assessment Report which operationalized it as a function of the nature and magnitude of climate variation, the degree to which a system is affected, and the ability of a system to adjust or cope with the consequences (McCarthy et al. 2001). This interpretation integrates three elemental abstractions: exposure, sensitivity and adaptive capacity (Figure 2).

Exposure refers to spatiotemporal events that indicate climate change, and is generally represented as a shift in some mean state, such as temperature or precipitation. Sensitivity denotes the responsiveness of a system (i.e., a city, a particular population or a sector) to those spatiotemporal events. Smit and Wandel (2006: 286) argue that exposure and

[10] Intergovernmental Panel on Climate Change

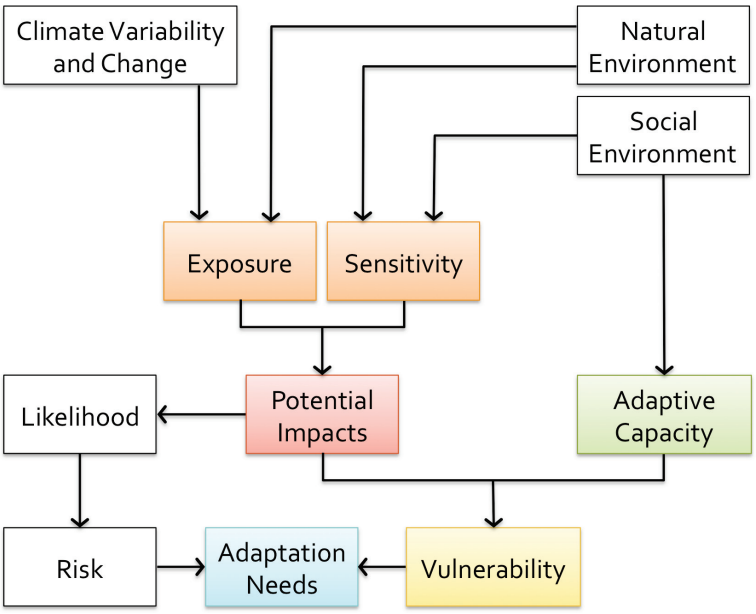

Figure 2: The components of vulnerability and their relationship to adaptation needs. Modified after Füssel and Klein (2006).

sensitivity are "inseparable properties" dependent on the interaction between local conditions (e.g., location, topography, land-use, livelihoods, infrastructure) and characteristics of the event (i.e., frequency, magnitude and duration). When combined, exposure and sensitivity express the potential impacts of climate change. Impacts are described here as "potential" because they do not account for autonomous adaptation, the spontaneous adjustments triggered by moderate deviations in normal climate (Füssel and Klein 2006).

Where the probability of a potential impact is known, the term risk is used. Risk is usually represented as the probability of occurrence of hazardous events or trends multiplied by the severity of impact, but these calculations can be either qualitatively or quantitatively (Jones 2001). Risk indicates a situation involving exposure to danger or the possibility of harm and is thereby closely related to the concept of vulnerability.

Adaptive capacity is the ability of a system to cope with risks and exploit opportunities related to change (Smit and Wandel 2006). It is a dynamic property that varies over time,

across space and among social groups. Determinants of adaptive capacity include access to economic resources, technology, information and skills, all of which are influenced by different types of capital (e.g., human, material, social, political), modes of governance, social institutions and entitlements (Brooks et al. 2005; Cutter et al. 2003; Vincent 2004). Adaptive capacity is a positive attribute of a system that reduces vulnerability by enabling adjustments "in response to actual or expected climatic stimuli or their effects" (McCarthy et al. 2001: 982). It is important to note that while adaptive capacity is critical for understanding what makes societies more or less *capable* of adapting to climate change, it does not automatically translate into adaptive action, especially at the local level (O'Brien et al. 2006).

Vulnerability to climate change is thus the relationship between potential impacts and adaptive capacity for a given set of circumstances (Figure 2). Assessments can be framed in terms of outcomes or contexts (described in detail on page 15), depending on the relative weighting of exposure, sensitivity and adaptive capacity (O'Brien et al. 2007). Although vulnerability signifies a potential state, as opposed to a realized outcome, vulnerability assessments are nonetheless useful for identifying adaptation needs that may be necessary or beneficial in response to climate change.

With the publication of its Fifth Assessment Report, the IPCC now defines vulnerability simply as "the propensity or predisposition to be adversely affected" (IPCC 2014: 5). The new definition offers ways of exploring local sensitivities and coping capacities without having to rely on model-based projections of change. It represents a risk framing concerned with the potential harm that may result from the effects of climate variability and change (Burkett et al. 2014). However, the new definition of vulnerability makes the need for values-based evaluations about what constitutes harm even more explicit (*cf.* O'Brien and Wolf 2010). In this dissertation I have used the IPCC's original definition of vulnerability while cognizant of the role values play in explaining the causes of

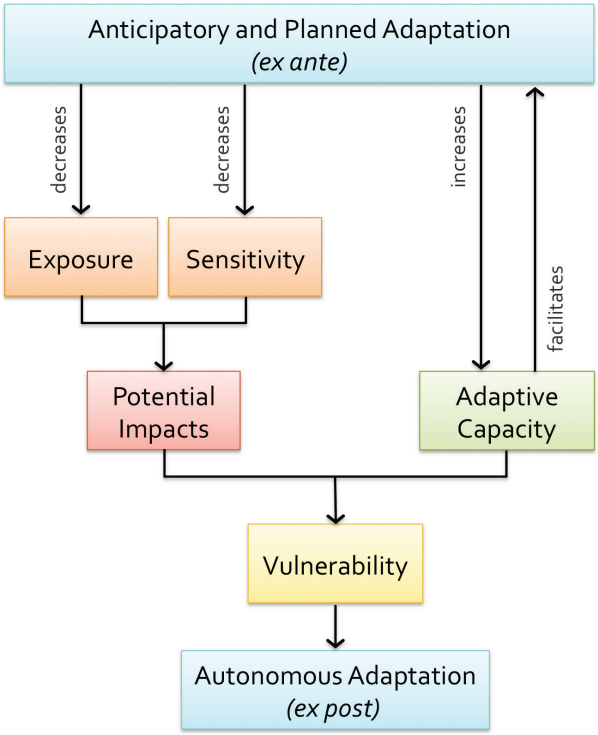

Figure 3: Relationships between adaptation and vulnerability.

vulnerability and identifying appropriate responses (O'Brien 2009). Consequently, in my use, "vulnerability" is not simply concerned with the negative material outcomes associated with climate change, but also how those outcomes are differentially perceived and valued.

ADAPTATION TO CLIMATE CHANGE

Adaptation is a process of ongoing adjustments that seeks to moderate (or avoid) harm or exploit beneficial opportunities associated with climate variability and change (Smit et al. 2000). It is based on the assumption that adaptive capacity can be used to minimize exposure and sensitivity to climate change and recover from shocks or stressors (Figure 3). Adaptation involves a wide range of actors in different echelons of society within both private and public spheres. It can be autonomous (e.g., relocating after a flood), anticipatory (e.g., purchasing flood insurance), or purposefully planned (e.g., rezoning flood-prone areas); planned adaptation is undertaken solely by governments as a deliberate

policy initiative and is the focus of this dissertation. Adaptation in the public sector may have close links with disaster preparedness, public health, sustainable development, urban planning, water management, et cetera, making it difficult to separate adaptive actions from measures initiated by other priorities (Füssel 2007).

In its most recent assessment report, the IPCC acknowledged that people and societies perceive and rank climatic risks differently based on differing values and goals. They write that "adaptation planning and implementation at all levels of governance are contingent on societal values, objectives, and risk perceptions; recognition of diverse interests, circumstances, social-cultural contexts, and expectations can benefit decision-making processes" (IPCC 2014: 26). An appreciation of the role that subjectivity plays in understanding change, causality and responses is fundamental to this dissertation. Even the distinction between mitigation and adaptation, commonly used in the climate change literature, is a subjective interpretation of climate change policy responses that do not always relate to lay-understandings and practices (O'Brien 2012; Pelling 2011). Thus unlike the IPCC, this dissertation does not make a clear distinction between mitigation and adaptation. Mitigation focuses on limiting changes in climate — and thereby decreases exposure — by altering activities related to greenhouse gas emissions. The capacity to mitigate climate change is driven by factors similar to the capacity to adapt (Klein et al. 2007). Furthermore, the ultimate effect of mitigation is a reduction of vulnerability to climate-related impacts, which is also the purpose of adaptation. I therefore consider mitigation to be a form of adaptation to climate change. This point is especially relevant to the reading of the second paper in this dissertation, which considers causal thinking and support for policies that reduce or delay climate change.

SPATIAL VULNERABILITY ASSESSMENTS

Because vulnerability to climate change is a relative condition, determined by the circumstances, processes and trends that vary across human landscapes, spatial analysis can be used to identify the harmful or unwanted consequences of climate change. In fact, spatial data integration with GIS has become a standard approach for assessments of vulnerability to climate change (Eikelboom and Janssen 2013; Preston et al. 2011b; de Sherbinin 2014; UNDP 2010).

Preston et al. (2011b) have identified two broad applications of spatial vulnerability assessments: problem-orientation and decision-support. On one hand, vulnerability assessments can be used to build an understanding of climate variability and change by identifying the key areas, sectors or populations that face weather and climate-related challenges. This is a critical first step — embarked upon when climate change is a concern, but its potential impacts and specific vulnerabilities are not well understood — that will typically guide subsequent work on adaptation. On the other hand, information about the factors underlying a system's vulnerability can serve as an entry point for identifying suitable adaptation interventions. Adaptation requires an understanding of the complexity of the system and how it changes, including decision-making processes, policy development, organizational culture and innovation, and risk perception. This means looking not just at what a system has that enables it to adapt, but also at what it does that enables it to adapt.

Assessing vulnerability within a spatial framework typically culminates in accessible and powerful communication devices (usually in the form of maps) that convey at a glance *where* vulnerable areas and populations exist and *why* they are vulnerable. Vulnerability maps can thus be thought of as cartographic texts that give meaning to climate change. Depending on how the driving forces are emphasized in the analysis, spatial vulnerability assessments can be framed as an outcome of the potential impacts of climate change, as a

social construction that manifests in the context of institutional and governance structures, or as a combination of biophysical and social processes that describe local circumstances either now or in the future (Figure 4). Outcome vulnerability is a quantitative, model-based analysis of the sensitivity of a particular system to changes in climatic conditions (e.g., higher temperatures, less rainfall, rising sea levels). The analytical focus is therefore on the biophysical determinants of vulnerability (i.e., exposure to climate change). Outcome vulnerability in Norway has been assessed spatially with regard to impacts on hydrological processes (Beldring et al. 2008), urban drainage systems (Nie et al. 2009), and agriculture (Uleberg et al. 2014). Contextual vulnerability assumes that exposure to climate change is mediated by adaptive capacity, which puts the analytical focus on the social determinants of vulnerability. Spatial assessments of contextual vulnerability rely on indicators to represent the structures, relationships and processes that mobilize resources within a system. Holand et al. (2011) have assessed the contextual vulnerability of municipalities in Norway by applying the Social Vulnerability Index (SoVI) after Cutter et al. (2003). SoVI is based on principal component analysis, which reduces the attributes of adaptive capacity in each municipality to a score that characterizes vulnerability relative to other municipalities.

As shown in Figure 4, when integrating the biophysical and social determinants of vulnerability it is also useful to distinguish between current and future states, which frames the assessment in terms of sensitivity to short-term shocks or long-term stressors. O'Brien et al. (2004) were among the first to explore the interaction between biophysical and social processes using a spatial — rather than a predictive — framework. By combining differential exposure, sensitivity and adaptive capacity at the municipal level, they showed that vulnerability to climate change varies greatly within Norway, a country generally considered to be resilient to the impacts of climate change. By demonstrating how the relevance of particular indicators changes with spatial scale and degree of data aggregation O'Brien and her colleagues showed that vulnerability and its causes are place-based. Local

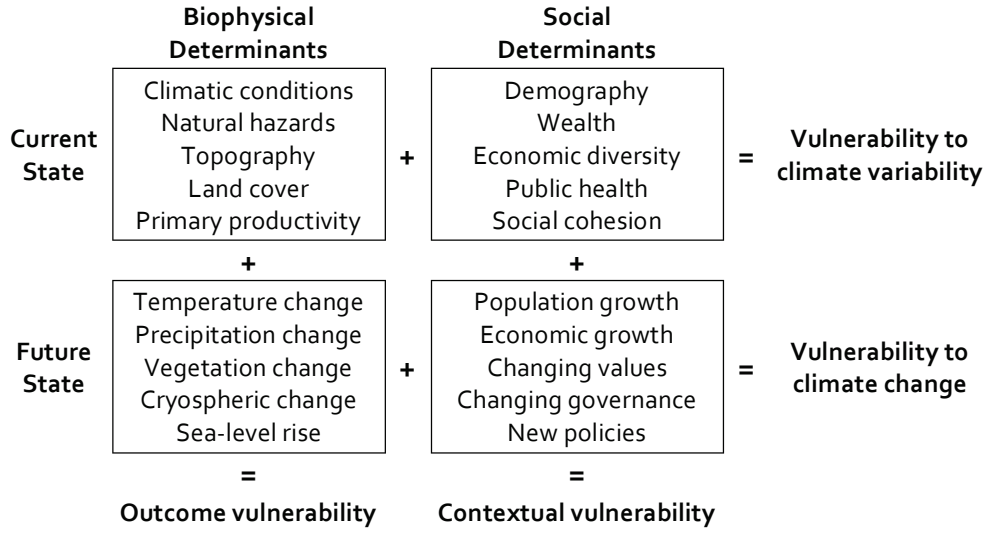

Figure 4: How driving forces frame the assessment of vulnerability. Modified after Preston and Stafford-Smith (2009).

planners in Norway now regularly do similar work to visualize weather and climate-related risks and meet statutory requirements (see, for example, www.klimagis.no).

QUALITATIVE GIS

GIS is largely understood as a tool for the storage and analysis of quantitative data, but Pavlovskaya (2006) has examined the conventional association of GIS with quantitative methods and argues that GIS is often not as quantitative as many practitioners assume; she suggests that there are "openings" that enable the use of GIS in qualitative research by incorporating the spatiality of social processes. Mapping vulnerability therefore has the potential to support collaborative processes in which diverse participants author flexible spatial narratives that explore different problem understandings as a means of generating a common, shared understanding.

Every application of GIS requires attention to what should be represented and how. The fundamental problem of GIS is that "the world is infinitely complex, but computer systems are finite" (Longley et al. 2011: 83). Consequently, GIS analysts must somehow

limit the amount of detail that is captured when developing a geographic database and creating visualizations. Choices are made throughout the process and all GIS representations are necessarily partial because they must ignore real-world features that are too complex or otherwise ambiguous. Kwan (2002) writes about the subjectivity of those who use GIS and the decisions involved in simplifying spatial models to build representations of the world. Her critical examination of GIS practices shows that different individuals see the world in different ways and what is left out of a representation is often just as important as what is included. This was the primary concern of critical geographers in the 1990s during the debates about GIS and society (Schuurman 2000; Sheppard 2005).

Human geographers generally agree that all observations are theory-laden and all actors are inherently biased by their cultural experiences and worldviews.[11] Eddy (2006; 2008) captured this idea by coining the phrase "geo-ontological contingency," which suggests that geographic information is neither right nor wrong but determined by who, what, where, when and how it is mapped. Today, after more than a decade of debate among GIS scholars and practitioners, it is commonly understood that GIS does not present a value-neutral view of the world, and instead simultaneously describes, masks and distorts reality (Carolan 2009). As a result, GIS has evolved to accommodate subjective appraisals of physical and human realities by incorporating qualitative research methods and mixed data types. Many technical barriers to data integration have fallen and qualitative GIS has emerged as a practice that acknowledges the positionality of GIS and the knowledge that can be produced with it (Wilson 2009).

The practice of qualitative GIS prioritizes stakeholder involvement in order to broaden the knowledge base when characterizing spatial problems. It is assumed that better decisions are implemented with less conflict and more success when stakeholders drive them (McCall and Dunn 2012). Table 1 compares conventional and qualitative forms of

[11] For examples that describe this effect in GIS see Crampton (2001), Harley (1989), Kwan (2002), Kyem (2004) and Aitken and Michel (1995).

Table 1: Comparisons between conventional GIS and qualitative GIS.

	Conventional GIS	Qualitative GIS
Approach	*Top-down* Expert driven based on aggregated indicators	*Bottom-up* Guided by the preferences and values of local-level actors
Data	*Cartesian spatiality* Discrete objects, continuous fields, raster cells, and their attributes	*Non-Cartesian spatiality* Complex connections, human experience, collective meanings
Methods	*Deductive analysis* Cluster detection, density and distance, map algebra, regression	*Inductive analysis* Surveys, interviews, focus groups, geocoding/geotagging, triangulation
Scale	*Generalizes local variation* Autocorrelation coefficients, geographically weighted regression	*Emphasizes interactions across scales* Multi-dimensional visualization; spatial, temporal, thematic navigation
Outcomes	*Data visualization* Generalization, statistical representations	*Knowledge production* Explanation, theoretical representations

GIS practice. Both are associated with graphical representations (i.e., maps) that help decision-makers understand and manage human activities. However, the outcomes of the respective practices differ and are achieved through contrasting approaches, data inputs, methods and representations of space. Much like conventional GIS practice, qualitative GIS pertains to the measurement, analysis and display of data, but it seeks situated understandings of social and environmental problems rather than statistical descriptions or generalizable predictions. Qualitative GIS adapts existing geospatial techniques for the interpretive analysis of geographic information — which can be expressed as narratives, texts, photographs, drawings, videos and animations — in order to represent people's "lived experiences" (Kwan 2002: 646). Where conventional GIS relies on a mastery of spatial science techniques, objective ways of knowing and positivist methods for decision-making, qualitative GIS attempts to model human reasoning, relying on qualitative research methods and promoting subjective ways of knowing that result in more inclusive policy interventions (Cope and Elwood 2009).

When it comes to assessing vulnerability to climate change, conventional GIS summarizes important demographic, environmental and socio-economic conditions (e.g., Preston et al. 2009), whereas qualitative GIS concentrates on the knowledge and experience of populations at risk (e.g., Tembo 2013). In this dissertation I have sought to combine those approaches based on the assumption that mixed-methods offer greater insights into the complexity and dynamics of human-environmental interactions. For example, in a study that explored how multiple stressors affect vulnerability, O'Brien et al. (2004) mapped indicators of the exposure, sensitivity and adaptive capacity of Indian farm populations to both climate change and globalization. The authors superimposed their composite map of vulnerability to climate change over another showing vulnerability to global economic change as a means of illustrating the effect of multiple stresses. They augmented the ensuing map with case studies using surveys and interviews to interpret the spatial relationships they observed and better explain the interaction of globalization and climate on the livelihoods of particular local populations. Their method corrects for one of the limitations of indicator-based approaches, which are commonly used in spatial vulnerability assessments yet fail to adequately represent adaptive capacity. By combining top-down and bottom-up approaches the authors were able to account for the dynamic processes that interact across geographic scales and influence vulnerability locally. In approaching the research design of this dissertation I saw a need to view vulnerability assessments as a process of deliberation between different adaptation actors, one that incorporates data from multiple scales and uses a suite of quantitative and qualitative methods to prioritize stakeholder perspectives on everything from problem definition to the validation of results.

RESEARCH DESIGN

This dissertation is a compilation of five papers that individually address separate aspects of my overarching research question. I have not employed a single methodology; rather I have used both qualitative and quantitative methods as appropriate to the individual sub-questions. Each paper is a stand-alone work that includes information about the theory and methodology relevant to its specific objectives. Nevertheless, the coherence of the papers taken together stems from a transdisciplinary framework based on integral theory. The next two sections describe my intellectual path toward integral theory and the rationale for prioritizing a transdisciplinary approach. This overview of the research design concludes with a section describing the data collected during my course of study.

METATHEORETICAL FOUNDATIONS

The precautionary principle is a decision-making strategy that guides policy makers and other social actors in situations where the possibility of harm exists yet complete scientific knowledge on the matter is lacking. The concept is exemplified by cautionary aphorisms like "better safe than sorry" and was formally defined by a self-appointed group of scientists, philosophers, lawyers and activists concerned with the impacts of human activities on the environment and human health. The final statement from their Wingspread Conference on the Precautionary Principle[12] says that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." The precautionary principle consists of four directives:

1. taking preventative action in the face of uncertainty;

2. shifting burdens onto proponents of potentially harmful activities;

[12] This conference took place January 23-25, 1998 at Wingspread in Racine, Wisconsin, the Johnson Foundation's educational center devoted to the free exchange of constructive and purposeful ideas. The complete text of the Wingspread Consensus Statement on the Precautionary Principle is available at www.sehn.org/wing.html.

3. exploring a wide range of alternatives to possibly harmful actions; and

4. increasing public participation in decision making.

Many have argued that climate change is an appropriate case for the application of the precautionary principle (e.g., Hallegatte 2009; Lempert 2002; Oppenheimer 2005), and indeed Norway's Planning and Building Act invokes it as a decision-making strategy for adaptation (*cf.* mainstreaming discussion on page 6).

In a context of growing awareness about major environmental issues such as acid rain, ozone depletion and climate change — all of which are characterized by complexity, uncertainty and potentially severe risks for both humans and ecosystems — Funtowicz and Ravetz (1990) assessed the scientific inputs to policies directed at environmental problems. They posited that while "policies can no longer be assumed to be based on scientific information endowed with a high degree of certainty" risk-management decisions do not in fact "require the elimination of uncertainty, but rather its effective management" (Funtowicz and Ravetz 1990: 1). In theorizing about the interaction of systems uncertainties and decision stakes, they defined a new approach for addressing global environmental problems called post-normal science (Funtowicz and Ravetz 1993; 1994).

Kuhn (1962) described the "normal" view of science as being focused on solving puzzles that are assumed to have solutions, thus making systems uncertainty low. Normal science is typically a curiosity-driven exercise, free of external interests, so the decision stakes are also low. Funtowicz and Ravetz (1993; 1994) argue that the policy needs associated with environmental risks cannot be met by the puzzle-solving exercises of normal science, because the science of environmental change is issue-driven (and thus value-laden) and robust solutions are not guaranteed (and are therefore uncertain). Hence, environmental science is post-normal. Post-normal science (PNS) is a "methodology of inquiry" appropriate in situations where the stakes are high, uncertainties large and decisions urgent (Turnpenny et al. 2011: 290). PNS embraces complexity and uncertainty

on the assumption that complex issues will never be fully understood before action is taken to manage them. Thus, if the precautionary principle is a *sensible* risk management strategy for climate change then PNS is the only *credible* risk management strategy, because irreversible harm is likely to occur before uncertainties about projected climate change can be eliminated.

PNS changes the model of science from formalized deduction to interactive dialog through the introduction of an extended peer community that evaluates scientific data alongside "extended facts" (i.e., value judgments and other subjective considerations) in order to make decisions about complex problems (Funtowicz and Ravetz 1993: 753). The enhanced involvement of stakeholders through the co-production of policy-relevant science is what attracted me to PNS. Participation of this kind provides access to a broader knowledge base that in turn improves problem definition, strengthens the analysis and increases acceptance of the results. It is increasingly recognized that climate change encompasses social, cultural and political beliefs that result in different understandings the problem and its solution (Hulme 2009; O'Brien 2009; Kahan et al. 2011). These multiple (and situated) knowledges reflect individuals' subjective positions about objective details and can become barriers to decision-making when they are not adequately taken into account (Moser and Ekstrom 2010; Gifford 2011).

Eddy (2006: 11) deconstructed situated knowledge in the context of sustainability and concluded that it is impossible to avoid either objectivity in detecting "what there is" or subjectivity in discerning "how it might be." He writes, "the same phenomena can be looked at from multiple perspectives, at multiple scales … and be simultaneously valued differently according to differences in circumstance" (Eddy 2006: 13). Hence, every individual brings forth and discloses a different and partial facet of reality based on who they are and how they see the world. Eddy (2006; 2008) calls this the geo-ontological contingency, which asserts that human knowledge is determined by a set of internal

boundary conditions consisting of subjective filters that interpret a set of external boundary conditions based on the spatial and temporal characteristics of the context. In other words, an individual's practical orientation to an issue is based on a "combination of data, knowledge and meaning, the interrelations of which involve non-linear interaction of inductive and deductive reasoning processes" (Eddy 2006: 20). Eddy's analysis of situated knowledge is derived from integral theory (Wilber 1996; Esbjörn-Hargens 2009), which also underpins this dissertation.

Integral theory provides a conceptual framework for purposeful, recursive data exploration from multiple viewpoints based on the fusion of ontology, epistemology and methodology (Esbjörn-Hargens 2009; Eddy 2008). It is conceptualized as quadrants that represent four basic perspectives from which anything can be studied: experience, culture, behavior and systems (Figure 5). The quadrants form at the intersection of two polarities that describe the subjective and objective and the individual and collective dualities of phenomena. More importantly, the individual quadrants do not stand in isolation, but rather integrate and shape one another. Integral theory is a metatheory that unifies two opposing philosophies of science: scientific realism and modernist thinking on the one hand and social constructivism and post-modernism on the other (Wilber 2000).

The realist ontology says that the world is absolute and should be studied through positivist methodologies that will lead epistemologically to universal truths. Realism gave rise to unprecedented scientific knowledge, technological progress and material wealth (in the Western world) during the 20th century, but faced criticism from post-modernists who questioned the universal appeal of Western values and argued instead that reality is in fact locally constructed (Benton and Craib 2011). Constructivists use methods that are explorative and interpretative, which results in knowledge that is always situated. Wilber (2000) saw post-modernism as a positive intellectual development in the sense that it deconstructed oppressive hierarchies, emphasized context and embraced pluralistic values,

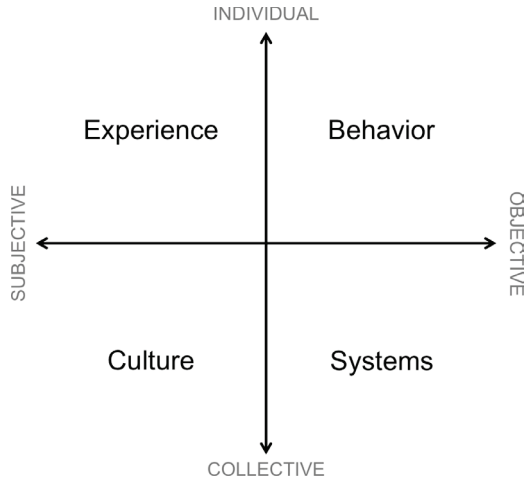

Figure 5: Integral theory uses quadrants to explain how different forms of knowledge combine into a coherent whole.

but in doing so it cut these perspectives free from any grounding in objective reality or universality. Like critical realism (Collier 1994), integral theory attempts to reintroduce the idea of universality into science, while retaining the post-modern understanding of difference and diversity. It seeks to integrate objective and subjective ways of understanding the world into a coherent epistemological framework that responds to the ways people actually experience reality.

Integral theory recognizes that subjective perspectives are linked to many lines of human development that include cognitive, emotional, interpersonal and moral capacities. Integral theorist Sean Esbjörn-Hargens (2009: 10) writes, "these capacities are often thought of as the multiple intelligences that each person has; the idea being that each of us is more developed in some areas than others." The developmental lines are important to integral theory because they identify distinct aspects of each quadrant that demonstrate evolution and potential, but they are not the focus of this dissertation. Rather, my interest is in the quadrants themselves, which represent the ontological and epistemological differences between the physical and social sciences, as well as divides in social theory (Antonio and Clark 2015). I have drawn on integral theory throughout this dissertation to

create a space for engagement that identifies what matters most within the extended peer communities of PNS. By recognizing that there are different understandings of climate change that often come across as binary and polarizing (i.e., believing and not believing in anthropogenic climate change; analytical emphasis on outcome vs. contextual vulnerability; prioritization of technical solutions over structural changes), integral theory can be used to connect climate information to other human processes and harmonize the multiple perspectives that are inherent to group decision-making.

TRANSDISCIPLINARITY AND MIXED METHODOLOGY

Integrating multiple ontologies for the purpose of effective decision-making calls for new ways of conducting research and communicating its results (O'Brien 2013). Climate change is a complex social issue necessitating an approach that is problem-oriented, a methodology that is tailored to the context, and a process that is interactive and reflexive (Mauser et al. 2013). In this dissertation I have therefore taken a transdisciplinary approach, using qualitative and quantitative methods at different stages of the research. Transdisciplinarity can be defined as a "reflexive … principle aiming at the solution or transition of societal problems … by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Lang et al. 2012: 26-27). It is distinguished by its 1) focus on real-world problems, 2) responsive methodology selection and 3) collaborative knowledge generation between researchers and stakeholders (Wickson et al. 2006). As a consequence, those features represent the three driving principles behind the methodological design of this dissertation.

The real-world problem addressed in this dissertation is how information about impacts and vulnerability can be communicated in a manner that facilitates adaptation, given multiple perceptions and ways of knowing. The complexity of climate change has given rise to the development of specialized boundary services aimed at decision-makers

for the express purpose of interpreting scientific results and framing policy options (Moser 2010; Vogel et al. 2007). However, despite the availability of boundary services that deliver policy-relevant information, there is little evidence of political action on adaptation to date. Moser and Ekstrom (2010: 22029) highlight many explanations for such limited action, including the "deeply held values and beliefs that influence how people perceive, interpret and think about risks and their management." Current understanding of the barriers to adaptation suggests that climate change is difficult to grasp for most lay audiences because it is fundamentally an ambiguous problem that is easily trumped by more direct experiences (Gifford 2011; Reser et al. 2014). I therefore set out to develop new strategies for assessing vulnerability based on the experiences and values of diverse actors in an effort to make the resulting information more credible and salient.

Carolan (2004) argues that as problems become more complex and more distant in terms of direct experience, methodological pluralism becomes an important strategy for developing the trust that is needed to bridge science and policy. The problem I set out to investigate could be addressed in any number of academic disciplines that fall under the broad umbrellas of environmental studies and risk communication, therefore no single methodology can be reasonably prescribed. I have therefore broken my problem down into different perspectives expressed as research questions that lend themselves to separate lines of inquiry within human geography (Table 2). The use of multiple methods allows the research problem to be examined from different viewpoints (Creswell 2009) and this approach has allowed me to be the most responsive to the different contexts under investigation.

Regarding process, most theorists describe transdisciplinary collaboration as knowledge generation between researchers and stakeholders (Lang et al. 2012; Mauser et al. 2013; Wickson et al. 2006). The new knowledge developed in this dissertation has not been co-created because the research was not designed as a unified case study. Rather, the

Table 2: The geographic research questions, traditions and methods used in this dissertation.

Research Question	Research Tradition	Research Method
1. What are the potentials of and limits to using climate scenarios in adaptation planning?	Environmental Geography	Observation and analysis
2. How do people understand climate change and perceive the effectiveness of different responses?	Environmental Perception & Behavioral Geography	Surveys with quantitative analysis
3. Why do many vulnerability assessments fail to engage stakeholders?	Vulnerability Science	Spatial Analysis, interviews and focus groups
4. What methods can be used to integrate and represent qualitative, contextual information with quantitative, scenario-based data?	Geographic Information Science	Qualitative GIS

dissertation is a theoretical exploration of how vulnerability is expressed, and the effect of that expression on the types of adaptations that are identified and prioritized. However, critical self-reflection was fostered through participant observation, surveys, interviews and contextual analysis, which provided evidence for how vulnerability involves knowledge associated with objective, exterior dimensions of climate change that focus on negative material outcomes as well as subjective, interior dimensions that address the meaning and relevance of those outcomes for specific individuals and groups. My interaction with different adaptation actors in Norway and abroad has exposed the assumptions, limitations and distortions contained within different understandings of vulnerability, including the partiality of my own understanding. In this way I have approximated the reflexivity called for by a transdisciplinary approach.

METHODS AND DATA

This section accounts for the general methods and key actors that informed this dissertation. Detailed information concerning specific research methods and data is provided in the individual papers.

For Paper I, which addresses the use of climate scenarios in adaptation planning, I participated in national workshops and local forums where stakeholders' information needs were discussed (Appendix 1), and I reviewed public documents about recommended tools and policy instruments for adaptation planning. At the start of my PhD program in 2008, there was a general sense of hope among local decision-makers that the downscaled scenarios of climate change being developed for the government's official public report on Norway's vulnerability (*cf.* page 4) would remove much of the uncertainty about projected changes at the local level. Together with the establishment of boundary services like the Climate Service Center[13] and a secretariat for climate adaptation,[14] local actors believed that much of the guesswork would soon be removed from adaptation planning. This led me to ask how scenarios were being used in other countries and what impact the Norwegian investment would likely have on local adaptation planning.

The genesis of Paper II was a course on psychological perspectives on climate change that I took during my program of study. A survey (Appendix 2) was administered in September 2009 to 207 undergraduate students majoring in economics or business administration at three Norwegian universities: University of Stavanger, Sogn og Fjordane University College in Sogndal, and BI Norwegian School of Management in Oslo. The data were collected for an international comparative study (Bostrom et al. 2012) that sought to control for cultural differences by selecting respondents with similar educational experiences. The decision to survey students majoring in economics or business administration was thought to minimize the risk that the respondents would be

[13] See www.klimaservicesenter.no
[14] See www.klimatilpasning.no

disproportionately concerned about climate change, as might be the case for environmental studies and related majors.

It is, for better or for worse, a well-known phenomenon that claims about human psychology and behavior are typically based on WEIRD (western, educated, industrialized, rich, and democratic) samples drawn from university students (Henrich et al. 2010). As I write in Paper II, on page 940, "although not necessarily representative of the Norwegian population as a whole, this sample does capture much of geographic diversity relevant to local discourses: three distinct regions (eastern, southern, and western Norway), as well as urban and rural communities, and private and public schools are represented." Rosentrater et al. (2013) has been read with interest by environmental psychologists (according to Thomson Reuters Web of Science it has currently been cited three times) and our data were recently used in a meta-analysis of the determinants and outcomes of belief in climate change (Hornsey et al. 2016).

Paper III is a post hoc evaluation of the CARAVAN screening tool developed with collaborators in Finland and Sweden. The target users for the tool were national and regional officials responsible for the care and welfare of the elderly, including representatives of social and health ministries, national health and welfare research institutes, umbrella bodies for various associations concerned with the welfare of the elderly, rescue and emergency services and organizations concerned with the planning and design of physical infrastructure for the elderly. My evaluation is based on nine interviews (Appendix 3) conducted by my collaborators with public officials in Finland and Sweden during the spring of 2010. No interviews could be arranged in Norway due to the low priority attached to social vulnerability by the potential users of the tool that I approached. A half-day stakeholder workshop (Appendix 4) was also organized in November 2010 at Stockholm University to formally present the screening tool and solicit feedback on how it might be refined or extended to enhance its usefulness for targeted users.

The experience of assessing social vulnerability is contrasted with the experience of assessing physical vulnerability in Paper IV. Invitations (Appendix 5) were sent to 30 public sector employees in Norway targeted for their knowledge of storm water management or experience on previous adaptation projects. Ten people attended the focus group, which was held in Oslo in January 2016. Participants included six employees of municipalities situated along the Oslo fjord, three employees at national regulatory agencies, and one private actor involved in land-use planning and construction. The purpose of the focus group was to better understand how adaptation in Norway occurs so that I could develop relevant questions for subsequent in-depth interviews with key adaptation actors.

Drawing on the results of the focus group, seven semi-structured interviews were conducted in January and February 2016 with individuals directly involved in either analysis or decision-making for climate change adaptation. Four interviewees worked for the municipality of Oslo and three interviewees worked for two different national agencies: the Norwegian Water Resources and Energy Directorate and the Norwegian Directorate of Public Construction and Property. Within this group, three were planners, three were GIS-analysts and one was an administrator. Only one of the interviewees had participated in the focus group. The interview questions (Appendix 6) focused on the practical steps taken when assessing vulnerability and making adaptation decisions, including how adaptation differs from other planning work.

The final paper of the dissertation, which asks what methods can be used to integrate and represent qualitative, contextual information with quantitative, scenario-based data, is a response to Paper III and the CARAVAN project in general. When the GIS tool we developed did not have the intended policy impact, I analyzed its shortcomings and proposed a new framework to close information gaps and build trust among assessment actors. Paper V is based on the feedback we received during the stakeholder workshop held in Stockholm, as well as on anecdotal information I collected from potential informants in Norway during stakeholder recruitment.

THE PAPERS

In this section I summarize the five papers that comprise this dissertation and provide information about the contexts in which they were written. To answer my overarching research question — *How can information about impacts and vulnerability be communicated in a manner that facilitates adaptation?* — the papers cover a wide range of factors that address the issue from different perspectives. The first paper is a review that critically examines one of the basic inputs to impacts and vulnerability studies: downscaled scenarios of climate change. The second paper describes an empirical study that shows how subjective filters are both significant and influential for responding to climate change. The third article, which is currently under review, is a post hoc examination of a vulnerability assessment that argues for new approaches to enhance the uptake of assessment results. The fourth paper, also under review, extends that argument by exploring how the contingent nature of vulnerability in spatial planning is revealed. The last paper, a book chapter, proposes a new assessment framework that considers the values and priorities of diverse social actors to foster a deep understanding of vulnerability.

THE POTENTIALS OF AND LIMITS TO CLIMATE SCENARIOS

In Rosentrater (2010) I explore how and to what end climate scenarios are used for adaptation planning. Although adaptation in Norway is seen as a local matter that should be managed within regulatory frameworks like the Plan and Building Act and the Civil Protection Act, the central government retains a responsibility to provide vetted information about climate change and its effects. In 2007, the government sponsored the development of high-resolution climate scenarios for the purpose of assisting local policy and decision-making. Recognizing that the government's decision was based on a deficit-model of communication, where information is assumed to mobilize action, I wanted to explore the actual utility of climate scenarios for adaptation decision-support.

Scenarios attempt to make understandable what is essentially abstract and difficult to represent in the imagination (Shearer 2005). They can be normative, exploratory, or even both. Normative scenarios are prescriptive and explicitly values-based, in that they describe a future that may be realized only through specific policy actions (e.g., a greenhouse gas stabilization scenario). In contrast, exploratory scenarios describe the future according to known processes of change by posing "what if?" questions. With much of human reasoning based on analogy rather than standard logic, the successful use of scenarios for responding to climate change depends on finding suitable analogical models grounded in the needs and capabilities of decision-makers (Morgan et al. 2002). Although the potential of climate scenarios lies in the insights they generate about complex system behavior, rule-based projections of the future are deterministic and leave little room for the human agency, innovation and social learning that are necessary for adaptation (Rosentrater 2010).

Figure 6 features some of the high-resolution scenario data developed on behalf of the Norwegian government for its boundary service Klimatilpasning.no (Climate Adaptation in Norway). Engen-Skaugen et al. (2008) produced a series of datasets on a 1 km by 1 km grid that describes current climate, future climate, and the difference between the two. The climate scenario represented in panel B is intended for use in impact models and vulnerability assessments, whereas the climate change scenario represented in panel C feeds directly into adaptation processes by answering the question "what are we adapting to?" My paper concluded that the availability of such information would not lead to better decision-making because climate-related decision support is more than the provision of information alone. Decision-support should be seen as a process of communication, mediation, translation, feedback and trust that supports heuristic engagements between adaptation actors. A survey of Norwegian policy makers conducted by the scenario developers since my article was published (Pilli-Sihvola et al. 2015) indicates that the scenarios are used for awareness raising and problem understanding but not for informing

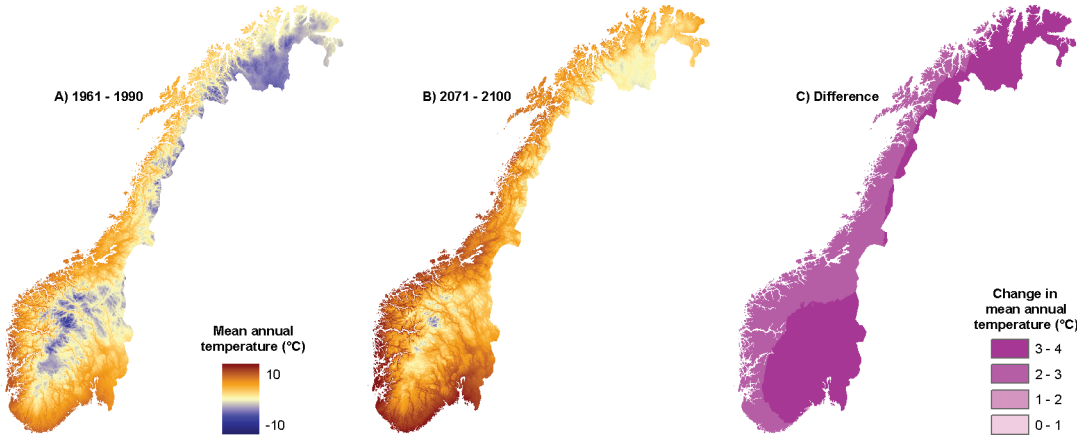

Figure 6: Annual mean temperature in Norway is mapped for the control period 1961-1990 (A) and simulated by a climate model for the period 2071-2100 (B). The difference between the two maps generates a climate change scenario (C).

adaptation decisions. My research shows that whether in relation to awareness raising or to informing adaptation, scenarios are limited because human cognition about distant problems is not fully rational and thus acts as a barrier to adaptation.

MENTAL MODELS OF CLIMATE CHANGE

In Rosentrater et al. (2013) I explore how Norwegians understand climate change and perceive the effectiveness of different responses. The data were collected for an international comparative study that describes the climate change policies people are willing to support and the reasons for their support of different policies (Bostrom et al. 2012). The survey looked at two classes of causal thinking about climate change: 1) perceptions of the causes and consequences of climate change and 2) perceptions of the effectiveness of proposed actions to reduce and delay climate change. Responses from Norway stood out from other countries so we decided to analyze the Norwegian data on its own. We found that the Norwegian respondents recognize that climate change poses a significant threat to nature and society, yet despite acknowledging the effectiveness of mitigation through direct regulation they are only willing to support policy actions that have an indirect effect on

climate change. The findings are significant because they undermine the deficit-model of communication that the Norwegian government has adopted to drive domestic responses to climate change.

A strong majority of the respondents we surveyed believe that anthropogenic climate change is occurring and identify carbon dioxide emissions as a cause; i.e., they have an accurate mental model of climate change and its causes. The analysis shows that respondents recognize the effectiveness of direct actions that require difficult trade-offs, such as imposing a carbon tax. Yet, their voting intentions suggest a preference for policies that have at best an indirect effect on reducing climate change. In fact, most respondents favor policy options that, while generally good for the environment (such as tree-planting initiatives and promoting higher fuel efficiency standards), require no behavioral change or personal sacrifice. The disconnection between perceptions about the effectiveness of direct actions and support for less effective mitigation approaches may reflect the respondents' collective distancing from the problem of climate change, which has been observed in other Norwegian studies (e.g., Norgaard 2011).

In the context of my dissertation, this article demonstrates how difficult it is for laypeople to engage with climate change on a pragmatic level. Even when individuals understand that easy policies are not particularly effective, they still seem to support them over difficult alternatives. Eddy's (2006; 2008) concept of the geo-ontological contingency becomes evident when looking at the data collected for this study. By and large, Norwegians believe that anthropogenic climate change is occurring and identify carbon dioxide emissions as a cause, but their subjective filters determine how they perceive and respond to climatic risks. For some Norwegians, the threatening nature of climate change — to individuals personally, to humankind, and to plants and animals — inspires support for some of the most direct risk reduction strategies, for example, by reducing personal consumption, limiting population growth and implementing a carbon tax. For

others, the negative social consequences of climate change (i.e., the likelihood of rising poverty, food shortages, increased rates of disease, and the prospect of climate refugees) are the dominant motivating factor, albeit for no-regrets approaches like reducing air pollution, funding research on renewable energy and trading carbon on open markets. Such diversity in motivating factors and thinking made me realize that responding to climate change requires the reconciliation of competing values and beliefs regarding risk and priorities. Overcoming a collective distancing from the problem of climate change may require more than objective data and information, as the next paper will show.

LESSONS LEARNED FROM MAPPING VULNERABILITY IN THE NORDIC REGION

The main case study supporting the findings in this dissertation involved developing an interactive screening tool that identifies vulnerability hotspots for guiding policy-driven analyses at smaller scales (Carter et al. 2016). The project was concerned with developing alternative approaches for characterizing vulnerability by capitalizing on the tacit knowledge held by stakeholders. A Web-based map application was developed that requires users to apply their own knowledge and judgment about the determinants of vulnerability to select the indicators that are of interest or relevant to them. So while the researchers were responsible for compiling the indicators used in the study, the actual assessment of vulnerability relies on stakeholder expertise to select and weight them.

The mapping tool evaluates three types of weather-related exposures associated with known impacts on the elderly: exposure to potential heat stress, exposure to potential cold stress, and exposure to potential icy conditions. Stakeholder feedback was solicited both during and after the development of the tool to validate the vulnerability indicators, and evaluate how the tool might inform adaptation planning. Five interviews were conducted in Finland and Sweden with a total of nine interview subjects. In Norway, two types of

stakeholders were contacted: public officials responsible for the planning and design of social and physical infrastructure for the elderly; and individuals over the age of sixty-seven. Surprisingly, the potential stakeholders we contacted said that the issue of climate change vulnerability among the elderly was not relevant to their activities or interests and we were therefore unable to secure Norwegian participation in the study. This prompted me to ask why vulnerability assessments seemingly fail to engage stakeholders in Norway. In Rosentrater (submitted) I address that question more generally by looking at issues related to salience, credibility and legitimacy.

Cash et al. (2003) discuss three factors that are important for the uptake of assessment results by policy makers. These are salience, which concerns the relevance of the assessment to the needs of policy makers; credibility, which relates to the reliability of the evidence and ensuing advice; and legitimacy, which indicates the perception that the views and interests of stakeholders have been adequately taken into account. My auto-critique revealed that researchers' own ontological and epistemological frameworks influence how vulnerability assessments are developed. In my paper I argue that knowledge about phenomena that are beyond direct measurement — such as vulnerability to climate change — is always partial and situated in a given context, which makes that knowledge open to interpretation and debate. Vulnerability assessments must start to support the enhanced involvement of stakeholders through the co-design and co-production of knowledge. Although participatory approaches have been used in several vulnerability studies, the praxis of co-design and co-production injects deliberative dialogues throughout the assessment process. Drawing on the feedback we received during the stakeholder workshop to evaluate the mapping tool, I argue that support for deliberation in vulnerability assessments requires the development of a new kind of framework that is fundamentally different from those that focus exclusively on analytical processes; it requires that vulnerability assessments become actor-centric, with mechanisms where biases, exclusions and assumptions are made explicit and are open to question and debate.

VULNERABILITY IN SPATIAL PLANNING

Vulnerability assessments are at the core of urban adaptation planning. They are used to identify needs and assess options for implementing adaptation measures, with the understanding that vulnerability is a potential state that reflects both climate-related impacts and the mechanisms that facilitate coping responses. In Rosentrater and O'Brien (submitted), I use the case of urban development in a flood-risk zone in Oslo to investigate how vulnerability is assessed under the Planning and Building Act, the regulatory framework for spatial planning and construction projects in Norway. The law stipulates that local planning authorities must ensure that risk and vulnerability assessments are conducted at two different stages of urban development, and that local planning authorities adopt the necessary zoning restrictions to prevent loss and damage.

Data collected for this study indicate that local planning authorities are using the Planning and Building Act to identify the localities that face weather and climate-related risks, but climate change is usually treated as an add-on to planning processes and is seldom the focus of urban development activities where a number of competing priorities must be weighed and balanced. Several of the planners we interviewed talked about the difficulty of evaluating the rigor and quality of the risk assessments submitted during land-use planning. They mentioned in particular the lack of transparency in setting the probability and consequence ratings and the ambiguity of the resulting risk rating, which can seemingly be at odds with the results of the vulnerability assessment conducted during master planning.

The linear planning process defined by the Planning and Building Act contributes to decisions that are biased towards regulatory interventions that miss critical opportunities for the transformative changes needed for climate resilient development. It is a planning framework that seeks to minimize risk without engaging in a transparent and deliberative process that confronts the values, interests, and tradeoffs associated with climate change

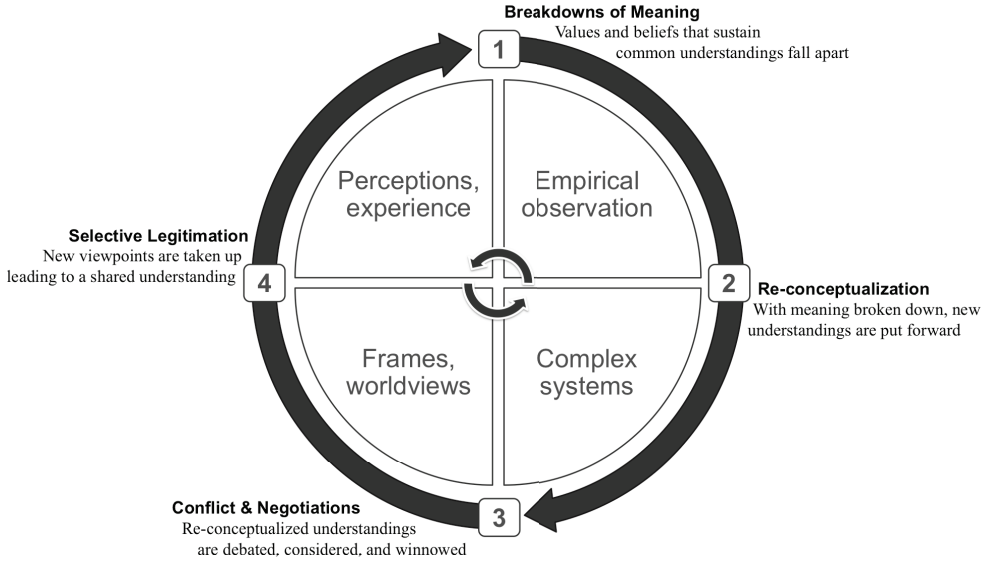

Figure 7: A model for analytic-deliberative decision-making that can be used to reconcile the competing points of view that influence adaptation decisions.

adaptation strategies – particularly risk avoidance strategies.

During the focus group, several participants expressed frustration over how adaptation decisions are made at the local level. There was general agreement that spatial planning always involves trade-offs and disagreements that can be attributed to the hidden and implicit assumptions of different actors involved throughout the process, especially market actors and politicians. We presented for them a model of analytic-deliberative decision-making based on integral theory (Figure 7) and discussed the need for iterative learning processes as a means of reconciling different points of view. The participants expressed a general desire for more coordinated and collaborative planning processes with one participant concluding, "a process like this is needed to create more *Aha!* experiences that can ground the evaluation criteria early in the planning process." This was an exciting result in the context of my overarching research question (see page 32) and should be seen as a bridge between my third and fourth research questions (see page 4).

RETHINKING VULNERABILITY ASSESSMENTS

In the final paper of this dissertation (Rosentrater 2015), I present a new assessment framework that facilitates a dialog in the contested space between ephemeral and measurable knowledge where several interpretations of vulnerability can be valid at the same time. I call the framework integral GIS and present it as a discursive strategy that merges conventional GIS and qualitative GIS practices to generate a more comprehensive model of reality by combining different forms of knowledge and knowledge seeking. The framework draws on integral theory, which posits that understanding vulnerability involves knowledge associated with objective data, which highlights negative material outcomes, as well as knowledge associated with subjective data that reveals the meaning and relevance of those outcomes for specific individuals and groups. To obtain a comprehensive mapping of vulnerability, highly contextual knowledge derived through qualitative GIS must augment systemic or rule-based knowledge based on conventional GIS (Figure 8). The premise is that the integration of both subjective and objective dimensions of vulnerability will yield insights by exposing discrepancies between the stories told by different types of knowledge.

Conventional GIS is used to analyze objective, exterior dimensions of climate change where traditional geospatial techniques are used to map aggregated indicators of vulnerability. The weighting of indicators can be done through either direct engagement with stakeholders (e.g., Preston et al. 2009) or software that allows individuals to customize the weightings interactively (e.g., Carter et al. 2016). Qualitative GIS delivers the subjective perspectives that generate a deep understanding of vulnerability, revealing multiple entry points for adaptation. Geo-narrative analysis (Kwan and Ding 2008) is used to analyze the experiences of those who are objectively vulnerable through their tacit knowledge, personal beliefs, and emotions. Personal experience with local changes or extreme events generates information about the determinants of vulnerability that is not accounted for in externally

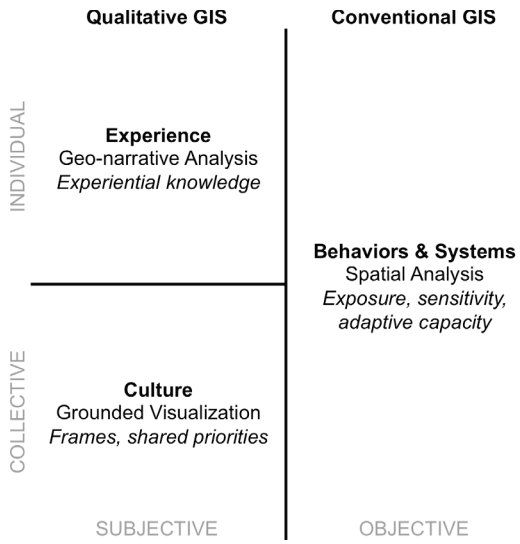

Figure 8: GIS methods and representative information for assessing vulnerability in an integral framework.

measurable indicators. At the same time, stories of the people, places and institutions that foster cohesion are useful for generating ideas about potential adaptations. These subjective mappings of vulnerability can also be collected through direct engagements with stakeholders (e.g., Tembo 2013) or software that allows various media types (i.e., text, photos, and sound) to be attached to specific geographic entities in the database (e.g., Rinner et al. 2008). To combine the mappings of objective and subjective vulnerability, grounded visualization (Knigge and Cope 2006) is used to identify the relationships between the different perspectives, revealing the ways in which vulnerability is framed and, subsequently, how adaptation is conditioned. This approach recognizes that adaptation is a social process and that its success relies on identifying and reconciling conflicting views and attitudes towards risk.

Such a multiple and systematic understanding of vulnerability brings transparency to the shared and private ideologies that act as filters through which adaptation actors interpret climatic risks and judge their implications. Moreover, an integral framework necessitates the use of an inclusive, participatory process that openly reflects the diverse

values represented by different actors, thus legitimizing the assessment process. Integral GIS is enacted through methods that are always being negotiated and open to experimentation. It is an iterative and reflexive process that facilitates social learning where adaptation actors (i.e., government representatives, outside experts, and various publics) work together to reconcile their different viewpoints. The aim is to support analytic-deliberative decision-making processes in which diverse participants author flexible spatial narratives that explore different problem understandings as a means of generating a common, shared understanding. My contention is that the value of assessing vulnerability should not be in the results of any single index, score or visualization, but rather in the range of explorations and analyses that can be carried out by building trust, closing information gaps and reconciling competing demands among interested parties.

This framework has yet to be tested, but it won the Judges Choice award[15] in MIT's Climate CoLab contest for identifying ways that cities can become more resilient to climate change. I was subsequently invited to present the framework at ICLEI's annual Resilient Cities conference in Bonn, Germany (Rosentrater 2014). Discussions with practitioners there both confirmed the need for new ways to contextualize subjective attitudes towards vulnerability, and revealed great interest in this approach for combining qualitative and quantitative analysis of both evidence-based and normative dimensions of climate change.

[15] See www.climatecolab.org/web/guest/plans/-/plans/contestId/14/planId/1304107

DISCUSSION

> *"Geography is increasingly characterized by multi-faceted intellectual practices and hybrid epistemologies. Critical GIScience has been directly engaging these hybridities for a decade, especially in its mixed methodological practices and attempts to foster epistemological flexibility in its knowledge production and representation strategies, and these efforts have a great deal to offer the discipline as whole" (Elwood 2006: 703).*

There is general agreement that the findings of vulnerability assessments can inform the planning and policy formulations of climate change adaptation by fulfilling two important functions: 1) they clarify the effects of climate variability and change by identifying the key areas, sectors and populations that face weather and climate-related challenges; and 2) information about the factors underlying a system's vulnerability serve as an entry point for identifying suitable adaptation interventions. Vulnerability assessments make use of diverse sets of methods to analyze the interactions between people and their physical and social surroundings. While much has already been written about challenges associated with assessing vulnerability to climate change (e.g., Engle 2011; Fekete et al. 2010; Hinkel 2011; O'Brien et al. 2007), this dissertation contributes to the literature by exploring how vulnerability is assessed and communicated within the context of adaptation planning.

Adaptation to climate change is already taking place in developed nations although few strategies have been implemented that specifically address the processes that shape vulnerability. By and large, the vast majority of local adaptation plans prescribe low-risk, non-structural interventions that promote awareness, build capacity through research and monitoring, and revise operating frameworks to guide subsequent planning (Preston et al. 2011a; Tompkins et al. 2010; Ford et al. 2011). A growing body of literature sheds light on the barriers that impede adaptation decisions. Generic barriers include poor leadership, inadequate resources, and individuals' mindset (Moser and Ekstrom 2010). Conflicting values and interests are among the most difficult barriers to overcome during adaptation planning. Since the causes of vulnerability are contested — especially those having to do

with individuals' capacities for adaptive action — adaptation hinges on actors' perceptions and beliefs about what climate change means for society.

Identifying adaptation needs is a social process, which makes planning procedurally difficult: a diverse assembly of interested parties, each with its own values and agendas, deliberates over the harmful or unwanted consequences of climate change. My critical examination suggests that vulnerability assessments fall short of expectations to inform adaptation policy because they do not accommodate the values-based evaluations of what constitutes harm. Abstract, scenario-based information alone does not motivate adaptive action (Rosentrater 2010) because diverse problem understandings lead to different preferences for how to respond to climate change, including biases toward complacency and inaction (Rosentrater et al. 2013). Heuristic engagements between adaptation actors enhance the relevance of vulnerability assessments for adaptation planning (Rosentrater submitted), and engagements that consider different forms of knowledge and knowledge seeking lead to a deeper understanding of vulnerability and thereby facilitate transformational responses to climate change (Rosentrater 2015).

Vulnerability assessments trigger a complex set of cognitive processes that encompass risk appraisal, sense-making, causal attributions and judgments that can lead to wildly different interpretations of the potential for harm and appropriate responses. Objective ways of knowing, i.e., through climate scenarios or quantitative indicators, pre-define the problem space by limiting the information used to contextualize climate change. The dominance of objective data privileges technical understandings of climate change and downplays the role of subjectivity in explaining the latent causes of vulnerability. As experience of climate change penetrates into society and adaptation becomes increasingly politicized, the value-laden knowledge that informs decision-making at both individual and collective levels must be integrated into assessment practices. The current state of methodological development for assessing vulnerability suggests an opportunity exists to

augment scientifically informed expertise with the values and beliefs that determine local governance. The way forward must include a wide range of actors in knowledge production; it must redefine the ways of knowing and making knowledge; and it must incorporate new forms of knowledge and representation into the assessment of vulnerability.

Integral GIS has been put forward in this dissertation as a promising opportunity to improve spatial vulnerability assessments and it is useful to consider how it is different from similar approaches. Public Participatory GIS (PPGIS), for example, is a common strategy for involving a wide range of actors in planning processes and overcome communication barriers. Indeed, the CARAVAN tool (Figure 1, page 9) is a form of PPGIS that relies on stakeholder participation to select and weight vulnerability indicators. Stakeholder knowledge is transferred to a model of vulnerability to make that model work, but the model itself is left intact. As a result, it is the model that frames the type of adaptations that can be identified for further consideration. This severely limits the extent to which issues of local circumstance, difference, and contingency can be included in vulnerability assessments. In contrast, integral GIS is an open process for social learning that encourages all actors – including the facilitators – to take a step back, reflect and use different lenses (e.g., experiential, cultural, behavioral and systemic) to articulate local concerns about climatic issues. It is envisioned as a form of co-production that draws upon interactive and participatory research methods for societal problem solving (Mauser et al. 2013).

The relevance of subjective ways of knowing and values-based criteria has only recently been acknowledged within the vulnerability community (e.g., O'Brien and Wolf 2010), while the discord between quantitative assessment approaches (Malone and Engle 2011) and qualitative approaches (Ford et al. 2010) has led some to question the utility of vulnerability as a framing concept for adaptation (e.g., Hinkel and Bisaro 2014). These

issues are reminiscent of the GIS & Society movement within the discipline of geography. After the disruptive "science wars" of the early 1990s, critical human geographers and GIScientists worked together to design and agree upon a shared research agenda focused on the social implications of mapping technologies (Schuurman 2000; Sheppard 2005). As the epigraph above suggests, mixed methodological practices and epistemological flexibility are a source of geography's intellectual vitality today. And as the papers in this dissertation attest, assessing vulnerability must evolve from quantitative or ex post exercises into collaborative processes of knowledge construction, in much the same way that GIS has evolved to accommodate lived experiences, personal histories and multiple agendas.

As geographers we seek to understand and interpret human experience in its socio-spatial settings. Conventional GIS helps to visualize the shape of social structures and the processes through which they are constructed; qualitative GIS works to convey individual experiences of places and events. Triangulating these methods has the potential to produce comprehensive meanings and stakeholder-focused results. At the level of day-to-day decision-making, adaptation planning depends on the way people communicate with each other and on their abilities to form consensus and compromise, rather than on their rationality and their abilities to analyze quantitative data. The questions implied by this dissertation should therefore serve as a roadmap for developing new participatory processes that lead to better decision-making: What kind of knowledge is legitimate for assessing vulnerability? What kinds of aspatial data are useful during the assessment process? What other ways of knowing are missing and yet important?

CONCLUSION

In order to understand the risks — and in some cases opportunities — that climate change poses, local decision-makers need information about impacts and vulnerability in

order to plan appropriate responses. The papers in this dissertation draw on geographic research traditions associated with environmental geography, behavioral geography, vulnerability science and GIScience to critically examine information about climate change impacts and vulnerability that is commonly made available to decision-makers to support adaptation planning. Vulnerability is a relative condition determined by the biophysical and social processes that describe local circumstances; the premise of assessing vulnerability is to understand the potential harm that may result from the effects of climate variability and change. Most assessment frameworks are based on objective (i.e., externally measureable) variables that quantify material outcomes without taking into account the non-material concerns (e.g., identity, beliefs and values) that are important to stakeholders. I have argued for the inclusion of such subjective evaluations and proposed an actor-centric framework based on factors that are important for the uptake of assessment results by policy makers.

Thanks to disciplinary advances achieved by critical GIScientists, mapping vulnerability has the potential to support analytic-deliberative processes in which diverse participants author flexible spatial narratives that explore different understandings of vulnerability as a means of generating a common, shared understanding. I have shown how a transdisciplinary framework based on integral theory can be used to account for the multiple perspectives that exist among adaptation actors. By using the deliberative components of spatial tools, the perceptions and beliefs about what climate change means for society can be made explicit and open to question and debate. Making the subjective aspects of vulnerability assessment more transparent is one way to reduce the objective veneer currently given to adaptation.

While vulnerability is widely recognized as being multidimensional, the human dimensions seldom stand out and are given short shrift during adaptation. This deficiency is likely to become more apparent since the IPCC has recently refocused its attention from vulnerability to risk. The Fifth Assessment Report asked how patterns of *risk* are shifting

due to climate change, drawing particular attention to the interaction of hazards (as a physical event or impact), exposure (the presence of people or activities that could be adversely affected) and vulnerability (the predisposition to be adversely affected, which encompasses a variety of concepts including sensitivity and lack of capacity to cope and adapt). The vocabulary is familiar, but the detailed definitions are new. More interestingly, the IPCC's reframing of adaptation "as a means to build resilience" (IPCC 2014: 25) does little to address the operational challenges of conducing credible, salient and legitimate assessments. It leaves unanswered the question of whose knowledge is considered appropriate for making sense of the capacity to cope. Just like assessing vulnerability, understanding climate-related risks is contingent on *who* is acquiring the knowledge (epistemology), *what* feature is being investigated (ontology), *where* and *when* (in space and time) the inquiry is situated, and *how* (methodologically) the inquiry is conducted. An essential task therefore remains as the scientific community enters the sixth assessment report cycle: how to elicit, handle and represent the ephemeral and personal meanings of risk.

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APPENDICES

Appendix 1: Stakeholder workshops attended in support of Paper I

Date	Meeting	Host/Sponsor
22-23 January 2008	Adapting Community Risk and Vulnerability Analyses for Climate Change	SAMRISK program at the Research Council of Norway
5-6 March 2008	Stakeholder workshop for NORADAPT	CICERO, Vestlandsforskning
15-18 October 2008	20th Annual Nordic GIS Conference	GeoForum
3-5 November 2008	Climate change adaptation in community planning	National Emergency Planning College (NUSB)

University of Bergen, Norway

Intervjuer no:

Intervju no:

Dato:

Appendix 2: Questionnaire about causal thinking and support for climate change policies

Dette er en internasjonal undersøkelse som utføres som en del av et doktorgradskurs ved Universitetet i Bergen. Hensikten med undersøkelsen er å forstå bedre hvordan folk tenker og føler om to aktuelle temaer: Klimaendringer og influensapandemier.

Vi setter stor pris på at du deltar. Svarene dine vil bidra til å informere beslutningstakere i næringslivet og statlige myndigheter om den offentlige opinionen i forskjellige land. Vennligst svar på spørsmålene så godt du kan, og i den rekkefølgen de står i. Ikke la noen spørsmål stå ubesvarte. Dine svar vil forbli anonyme. Takk for ditt bidrag!

1. Vennligst sett en ring rundt det tallet som passer best med din oppfatning. Du får først noen spørsmål om klimaendringer, og så noen spørsmål influensapandemier.

Spørsmål om klimaendringer:

a.	Hvor godt blir klimaendringer forstått av vitenskapen?	Ingen god forståelse	1	2	3	4	5	6	7	Svært god forståelse
b.	Hvor alvorlig trussel er klimaendinger for deg personlig?	Ingen trussel	1	2	3	4	5	6	7	Svært alvorlig trussel
c.	Hvor alvorlig trussel er klimaendinger for menneskeheten?	Ingen trussel	1	2	3	4	5	6	7	Svært alvorlig trussel
d.	Hvor alvorlig trussel er klimaendinger for planter og dyr?	Ingen trussel	1	2	3	4	5	6	7	Svært alvorlig trussel
e.	Hvor store fordeler får menneskene av klimaendringer?	Ingen fordeler	1	2	3	4	5	6	7	Svært store fordeler
f.	I hvilken grad er det mulig å kontrollere konsekvensene av klimaendringer?	Kan ikke kontrolleres	1	2	3	4	5	6	7	Kan kontrolleres fullt ut
g.	Føler du frykt når du tenker på klimaendringer?	Ingen frykt	1	2	3	4	5	6	7	Svært sterk frykt
h.	Hvor mye kan du selv bidra til å redusere eller stanse klimaendringer?	Kan ikke bidra personlig	1	2	3	4	5	6	7	Kan bidra svært mye personlig
i.	Er risikoer og fordeler av klimaendringer rettferdig fordelt mellom mennesker i verden?	Svært rettferdig fordelt	1	2	3	4	5	6	7	Svært **u**rettferdig fordelt
j.	Hvor godt informert er du om klimaendringer?	Ikke informert	1	2	3	4	5	6	7	Svært godt informert

k. I hvilken grad har du moralske betenkeligheter om klimaendringer?	Ingen moralske betenkeligheter	1	2	3	4	5	6	7	Sterke moralske betenkeligheter
l. Hvor raskt vil vi merke konsekvensene av klimaendringer?	Umiddelbart	1	2	3	4	5	6	7	Langt inn i fremtiden

Spørsmål om influensapandemier:

m. Hvor godt blir influensapandemier forstått av vitenskapen?	Ingen god forståelse	1	2	3	4	5	6	7	Svært god forståelse
n. Hvor alvorlig trussel er influensapandemier for deg personlig?	Ingen trussel	1	2	3	4	5	6	7	Svært alvorlig trussel
o. Hvor alvorlig trussel er influensapandemier for menneskeheten?	Ingen trussel	1	2	3	4	5	6	7	Svært alvorlig trussel
p. Hvor alvorlig trussel er influensapandemier for planter og dyr?	Ingen trussel	1	2	3	4	5	6	7	Svært alvorlig trussel
q. Hvor store fordeler får menneskene av influensapandemier?	Ingen fordeler	1	2	3	4	5	6	7	Svært store fordeler
r. I hvilken grad er det mulig å kontrollere konsekvensene av influensapandemier?	Kan ikke kontrolleres	1	2	3	4	5	6	7	Kan kontrolleres fullt ut
s. Føler du frykt når du tenker på influensapandemier?	Ingen frykt	1	2	3	4	5	6	7	Svært sterk frykt
t. Hvor mye kan du selv bidra til å redusere eller stanse influensapandemier?	Kan ikke bidra personlig	1	2	3	4	5	6	7	Kan bidra svært mye personlig
u. Er risikoer og fordeler av influensapandemier rettferdig fordelt mellom mennesker i verden?	Svært rettferdig fordelt	1	2	3	4	5	6	7	Svært **u**rettferdig fordelt
v. Hvor godt informert er du om influensapandemier?	Ikke informert	1	2	3	4	5	6	7	Svært godt informert
w. I hvilken grad har du moralske betenkeligheter om influensapandemier?	Ingen moralske betenkeligheter	1	2	3	4	5	6	7	Sterke moralske betenkeligheter

x. Hvor raskt vil vi merke av konsekvensene av influensapandemier? Umiddelbart 1 2 3 4 5 6 7 Langt inn i fremtiden

2. Hvor sannsynlig tror du det er at menneskelige aktiviteter har ført til globale klimaendringer? (Sett en ring rundt det tallet som passer best med din oppfatning.)

Svært usannsynlig	Ganske usannsynlig	Litt usannsynlig	Like sannsynlig som usannsynlig	Litt sannsynlig	Ganske Sannsynlig	Svært sannsynlig
1	2	3	4	5	6	7

3. Uavhengig av hvor mye du føler du kan om klimaet, vurder *så godt du kan* i hvilken grad aktivitetene på listen under forårsaker klimaendringer. Sett ring rundt ett tall for hver påstand.

a. Det at folk kjører bil Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

b. Det at folk varmer opp og kjøler ned husene sine Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

c. Atomkraft Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

d. Bruk av elektrisitet fra kull og olje Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

e. Bruk av spraybokser som inneholder ozonnedbrytende stoffer Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

f. Hull i ozonlaget i den øvre atmosfæren Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

g. Ødeleggelse av tropisk regnskog Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

h. Luftforurensning fra giftige kjemikalier Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

i. Vulkanutbrudd Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

j. Befolkningsvekst Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

k. Dyrehold til kjøttproduksjon Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

l. Utslipp av karbondioksid (CO_2) Slett ikke en årsak 1 – 2 – 3 – 4 – 5 – 6 – 7 En viktig årsak

4. For hvert punkt på listen under, ranger hvor sannsynlig du tror det er at dette skjer som en konsekvens av klimaendringer innen år 2050.

	Svært usannsynlig 1	Ganske usannsynlig 2	Litt usannsynlig 3	Like sannsynlig som usannsynlig 4	Litt sannsynlig 5	Ganske sannsynlig 6	Svært sannsynlig 7
a. Matmangel mange steder i verden	1	2	3	4	5	6	7
b. Matmangel der du bor	1	2	3	4	5	6	7
c. Økt fattigdom mange steder i verden	1	2	3	4	5	6	7
d. Økte forekomster av alvorlige sykdommer over hele verden	1	2	3	4	5	6	7
e. Klimaflyktninger	1	2	3	4	5	6	7
f. Økt sjanse for at du vil få en alvorlig sykdom	1	2	3	4	5	6	7
g. Nedgang i din levestandard	1	2	3	4	5	6	7
h. Øystater forsvinner på grunn av havnivåstigning	1	2	3	4	5	6	7
i. Massiv utryddelse av plante- og dyrearter	1	2	3	4	5	6	7
j. Flere og større stormer mange steder i verden	1	2	3	4	5	6	7
k. Flere og lengre tørkeperioder mange steder i verden	1	2	3	4	5	6	7

5. Nedenfor finner du en liste over mulige tiltak som kan være med på å redusere eller stanse klimaendringer. For hvert av forslagene på listen, skal du tenke deg at dette er det eneste klimatiltaket som blir gjennomført. Vurder ut fra dette hvilken effekt du tror hvert av tiltakene vil ha på klimaendringene. Sett en ring rundt det tallet som passer best. Anta at tiltaket blir gjennomført over hele verden, dersom dette spiller noen rolle for svaret ditt.

	Redusere eller stanse klima-endringer			Verken redusere eller øke			Øke klima-endringer
	1	2	3	4	5	6	7
a. Øke skattene på fossilt brensel (for eksempel bensin, olje, kull og parafin)	1	2	3	4	5	6	7
b. Gjødsle havet for å øke algeproduksjonen	1	2	3	4	5	6	7
c. Finansiere forskning som kan bidra til rimeligere og mer effektiv fornybar energi	1	2	3	4	5	6	7
d. Redusere luftforurensing fra giftige kjemikalier	1	2	3	4	5	6	7
e. Endre livsstil for å redusere forbruket	1	2	3	4	5	6	7
f. I stor grad erstatte fossilt brensel med atomkraft	1	2	3	4	5	6	7
g. Begrense befolkningsveksten	1	2	3	4	5	6	7
h. Skape et internasjonalt marked for kjøp og salg av karbondioksid (CO_2)-kvoter	1	2	3	4	5	6	7
i. Tilføre mer støv til atmosfæren	1	2	3	4	5	6	7
j. Krav om at biler og lastebiler skal ha lavere drivstofforbruk	1	2	3	4	5	6	7

	Redusere eller stanse klima-endringer			Verken redusere eller øke			Øke klima-endringer
	1	2	3	4	5	6	7
k. Plante trær	1	2	3	4	5	6	7

6. Nedenfor ser du den samme listen om igjen over mulige tiltak for å redusere eller stanse klimaendringer. Hvordan ville du stemt for disse tiltakene i en nasjonal folkeavstemning?

	Definitivt nei	Mest sannsynlig nei	Vet ikke	Mest sannsynlig ja	Definitivt ja
	1	2	3	4	5
a. Øke skattene på fossilt brensel (for eksempel bensin, olje, kull og parafin)	1	2	3	4	5
b. Gjødsle havet for å øke algeproduksjonen	1	2	3	4	5
c. Finansiere forskning som kan bidra til rimeligere og mer effektiv fornybar energi	1	2	3	4	5
d. Redusere luftforurensing fra giftige kjemikalier	1	2	3	4	5
e. Endre livsstil for å redusere forbruket	1	2	3	4	5
f. I stor grad erstatte fossilt brensel med atomkraft	1	2	3	4	5
g. Begrense befolkningsveksten	1	2	3	4	5
h. Skape et internasjonalt marked for kjøp og salg av karbondioksid (CO_2)-kvoter	1	2	3	4	5
i. Tilføre mer støv til atmosfæren	1	2	3	4	5
j. Krav om at biler og lastebiler skal ha lavere drivstofforbruk	1	2	3	4	5

	Definitivt nei	Mest sannsynlig nei	Vet ikke	Mest sannsynlig ja	Definitivt ja
	1	2	3	4	5
k. Plante trær	1	2	3	4	5

6. For hvert punkt på listen under, ranger hvor mye ansvar du mener de ulike partene har for å gjøre noe med klimaendringene.

	Svært enig	Ganske enig	Litt enig	Verken enig eller uenig	Litt uenig	Ganske uenig	Svært uenig
	1	2	3	4	5	6	7
h. Norske politikere har et stort ansvar for å forhindre klimaendringer	1	2	3	4	5	6	7
i. Næringslivet i Norge har et stort ansvar for å forhindre klimaendringer	1	2	3	4	5	6	7
j. Frivillige organisasjoner har et stort ansvar for å forhindre klima-endringer	1	2	3	4	5	6	7
k. Internasjonale organer (som f.eks FN, EU) har et stort ansvar for å forhindre klima-endringer	1	2	3	4	5	6	7
l. Hver enkelt med våre handlinger har et stort ansvar for å forhindre klimaendringer	1	2	3	4	5	6	7

7. Vurder hvor mye de ulike partene nedenfor faktisk **bør gjøre** for å forhindre konsekvenser av klimaendringer.

	burde gjøre mye mer	burde gjøre mer	burde gjøre litt mer	gjør akkurat passe	burde gjøre litt mindre	burde gjøre mindre	burde gjøre mye mindre
	1	2	3	4	5	6	7
m. Norske politikere	1	2	3	4	5	6	7
n. Næringslivet i Norge	1	2	3	4	5	6	7
o. Frivillige organisasjoner	1	2	3	4	5	6	7
p. Internasjonale organ (som f.eks FN, EU)	1	2	3	4	5	6	7
q. Hver enkelt med våre handlinger	1	2	3	4	5	6	7

7. Når er du født? 19 __ __

8. Kjønn? (sett en ring rundt rett svar) M K

9. Hvor mange år har du studert (etter ungdomskolen)? _____ år

10. Hvor lenge har du bodd i Oslo? _____ år _____måneder

11. Hvilket studieprogram tilhører du? (Vennligst fyll inn)

    _____

12. I hvilket studieår på bachelorprogrammet er du? (Vennligst sett en ring rundt rett tall)

    1 2 3

Tusen takk for at du tok deg tid til å svare på denne undersøkelsen!

CARAVAN INTERVIEW GUIDE: Public officials

Climate change: background

What do you associate with the term climate change? Do you think climate change is an issue that relates to extreme weather events, or gradual change over time (neither/ both?)

Which of these do you see as more important for Finland/Norway/Sweden?

Do you think that climate change could have consequences for Norwegian/Swedish/Finnish society?

- What do you see as the most severe consequences?

Do you feel you have enough information about climate change? What kind of information do you feel you lack, if any?

Climate change and health

What are the most important health impacts of climate change in Finland/Norway/Sweden?

- How important do you consider them?

Has climate change taken into account in your organisation's activities or future planning?

- If yes, how?
- If not, why?

Climate change and the elderly

How familiar are you with the issue that one becomes more vulnerable to ambient temperature or extreme weather events, the older one gets?

Do you see the growing likelihood of heatwaves as a threat for elderly people in Finland/Norway/Sweden?

What do you think makes a person especially vulnerable to high temperatures?

- (e.g. living alone, poor state of health (physical/mental), dementia, poor economic situation, few social networks, living in rural/urban areas…?)

What do you think are the most important climate- or weather-related challenges that elderly populations face?
Heat waves, cold spells, extreme snowfall, storms, floods, icing?

- How can these affect elderly people?

How much are there regional differences in terms of access to health care services among the elderly?

- What are the main causes for the differences?
- Which areas are better/worse off?

What do you see as future trends in the healthcare of the elderly?

in relation to:

- Institutions vs. home care
- Equality / inequality in access to health services
- Local / regional / national emphasis on the management of public health
- Migration / immigration of the elderly (e.g. increasing amount of retirees moving permanently to their summer cottages, seasonal or permanent living in warmer countries)
- Other trends?

What do you see as main challenges in public health services for the elderly?

What kind of measures could be taken in elderly care to prepare for the impacts of climate change and prevent negative impacts?

- On what level would the most important measures be taken and who would be the key actors?

Conclusion

Is there anything you would like to add/ask? (Suggestions about other interviewees, publications etc.)

Climate change vulnerability mapping for the Nordic region

CARAVAN/MEDIATION Joint Workshop, Tuesday 9 November 2010
Organised in association with the NORDCLAD-Net International Conference:
***Climate Adaptation in the Nordic Countries: Science, Practice, Policy* (8-10 Nov 2010)**

Location: Kungstenen (7th Floor), Aula Magna, Stockholm University, Sweden

Final Programme

13:00 – 13:30	**Registration**
13:30 – 13:45	Welcome, introduction to Workshop and round table introductions (Name, Position, Institution, Interest in Workshop) ***Timothy Carter**, Climate Change Programme, Finnish Environment Institute (SYKE)*
13:45 – 14:00	Reflections on the CIRCLE Nordic Call ***Marianne Lilliesköld,** Swedish Environmental Protection Agency, Stockholm*
14:00 – 15:30	***Session I: Vulnerability of the elderly to climate change in the Nordic region*** *Chair: Timothy Carter*
14:00 – 14:15	Climate change in the Nordic region: who is vulnerable? ***Karen O'Brien**, Dept of Sociology & Human Geography, University of Oslo*
14:15 – 14:30	Characterising vulnerability of the elderly for CARAVAN ***Hanna Mela**, Climate Change Programme, Finnish Environment Institute (SYKE)*
14:30 – 15:00	Perspectives on climate change risks for the elderly: ***Pia Westford**, Swedish Civil Contingency Agency, Karlstad* ***Sari Jokinen**, National Institute for Health and Welfare (THL), Helsinki*
15:00 – 15:15	Results of a mini-survey on perceptions of climate change risk for the elderly ***Louise Simonsson,** Centre for Climate Science & Policy, University of Linköping*
15:15 – 15:30	General discussion: Vulnerability of the elderly to climate change
15:30 – 16:00	**Refreshments**
16:00 – 17:30	***Session II: Web-based vulnerability mapping tool*** *Chair: Karen O'Brien*
16:00 – 16:15	Design and elements of the CARAVAN mapping tool ***Stefan Fronzek**, Climate Change Programme, Finnish Environment Institute (SYKE)*
16:15 – 16:30	Online demonstration of the CARAVAN mapping tool ***Lynn Rosentrater**, Dept of Sociology & Human Geography, University of Oslo*
16:30 – 17:00	Observations and feedback on the mapping tool and general discussion ***Susanna Kankaanpää**, Helsinki Region Environmental Services Authority (HSY)* ***Emilie Mahlström**, Swedish Association for Local Authorities & Regions, Stockholm* ***Maria Khovanskaia,** Environmental Policy Directorate, REC, Szentendre, Hungary*
17:00 – 17:15	Vulnerability assessment in the context of the MEDIATION project ***Reinhard Mechler**, Vulnerability and Risk Program, IIASA, Laxenburg, Austria*
17:15 – 17:25	Discussion
17:25 – 17:30	Closing remarks and next steps: from CARAVAN to MEDIATION ***Timothy Carter**, Climate Change Programme, Finnish Environment Institute (SYKE)*
17:30	**Close and depart to NORDCLAD-Net Conference Reception at City Hall**

Klimatilpasning i praksis — anvendelse av lovverk

Universitetet i Oslo og Klima 2050 ved SINTEF Byggforsk inviterer til fokusgruppe torsdag **14. januar 2016** med temaet klimatilpasning i praksis.

Klimatilpasning består av forskjellige typer politiske problemstillinger som involverer mange ulike typer aktører, geografiske skalaer og tidsskalaer. Beslutningsgrunnlaget for en tilpasningsplan omfatter blant annet lover og overordnede føringer, forskningsbaserte data og kjennskap til lokale forhold og egen virksomhet. Det komplekse grunnlaget krever integrering av ulike datatyper og interesseavveininger, og dette skaper nye utfordringer for planlegging.

Hovedformålet med fokusgruppen er å belyse balansen mellom saklige og skjønnsmessige vurderinger knyttet til lokal klimatilpasning. Aktuelle deltakere for fokusgruppen er fagpersoner som arbeider med GIS-analyse, planleggere, arkitekter og andre aktører innenfor offentlig forvaltning med ansvar for oppfølging av utredningskrav etter Plan- og bygningsloven. Vi kommer til å sette fokus på praktisk oppgaveløsning med eksempler fra skadehendelser knyttet til flom og overvann. Informasjon som fremkommer fra deltakerne under fokusgruppen vil bli brukt i et doktorgradsprosjekt om læringsprosesser i klimatilpasning.

Praktisk informasjon

Samlingen tar form av gruppediskusjoner som dekker følgende emner:

- Erfaringsutveksling om tilpasningsutfordringer
- Samordning på tvers av sektorene i kommunen
- Innhenting av ny kunnskap
- GIS-analyser og bestemmelser
- Aktiv medvirkning

Sted: SINTEF Byggforsk, Forskningsveien 3B, 0373 Oslo
Tid: 14. januar 2016, kl. 12:30-15:30

Innledende faglunsj:
Deltakere i fokusgruppen invitertes til en faglunsj i regi av Klima 2050 fra kl. 11:45 til 12:30 i samme lokale. Nathalie Labonnote fra SINTEF Byggeforsk legger frem pågående forskning på tematiske geodata om skadehendelser knyttet til flom og overvann.

Påmelding: Gjøres på <lenke til nettskjema> senest 11. januar 2016. **Gratis deltakelse med enkel servering.**

Ønsker du mer informasjon kan du kontakte:
Cecilie Flyen, seniorforsker, e-post cecilie.flyen@sintef.no, mob: 971 83 297
Lynn Rosentrater, doktorand, e-post lynn.rosentrater@sosgeo.uio.no, mob: 930 93 818

Intervjuspørsmål
Målgruppen: planleggere og aktører innenfor offentlig forvaltning

Retningslinjer

- Be om tillatelse til å ta opp intervjuet
- Beskriv kort studien
- Start med spørsmålene (intervju lengde: ca 45-60 minutter)

Bakgrunns spørsmål

1. Hvor jobber du? (etat, avdelingen)
2. Hva gjør du der? (planlegger, ingeniør, arkitekt, geodata, leder, annet)
3. Hvor lenge har du jobben i dette feltet?
4. Fortell meg litt om de overordnede oppgaver du jobber med?
5. Hvor ofte bruke du GIS? (daglig → sjeldent)
6. Etter din mening, hvilken betydning har geodata/kart for planprosesser?

Klimaendringer og beslutningsprosesser

7. Anses klimatilpasning til å være en viktig del av det din organisasjon jobber med? Er dette en politisk eller administrativ sak? Eksempler?
8. I hvilken grad jobber du med klimatilpasning?
9. Klimatilpasning skaper nye utfordringer for planlegging. Tilpasning består av forskjellige typer politiske problemstillinger som involverer mange ulike typer aktører, geografiske skalaer og tidsskalaer. Hvilke beslutningsgrunnlag er relevant for klimatilpasning (**evt. planleggingsprosesser**)?
    - lover og overordnede føringer
    - forskningsbaserte data (klimaframskrivninger, klima og hydrologiske data)
    - utredninger (konsekvensutredning, ROS-analyse)
    - skjønnsmessige vurderinger (kjennskap til lokale forhold og egen virksomhet)
10. Hvordan integrerer man disse ulike datatyper og interesseavveiinger? Si litt om fremgangsmåter.

Medvirkning

11. I hvilken grad jobber du med publikum eller andre aktører i medvirkningsprosesser?
12. Har du selv organisert eller tilrettelagt medvirkningsprosesser?
13. Hva er de viktigste fordelene ved bruk av kartbaserte teknologier i medvirkningsprosesser?
14. Hva er de viktigste begrensinger ved bruk av kartbaserte teknologier i medvirkningsprosesser?

Slutt

15. Har du lyst til å si noe annet vi kanskje ikke har snakket om?
16. Er det noen andre du synes jeg bør snakke med?

Tusen takk!

Intervjuspørsmål
Målgruppen: GIS-analytikere eller statlige aktører innenfor infrastruktur

Retningslinjer

- Be om tillatelse til å ta opp intervjuet
- Beskriv kort studien

Bakgrunns spørsmål

17. Hvor jobber du og hva gjør du der? Si litt om de overordnede oppgaver du jobber med.

Kartlegging av flomfare

18. Beskrive prosessen for å kartlegge flomfare og særlig grunnlagsdata som brukes i beregninger (terrengsmodeller, nedbørsdata, avrenningsfaktorer, bygg og infrastructure, skadedata)
19. Hvilke skjønnsmessige vurderinger brukes is kartleggingen?
    a. Hvilke data kunne du tenke å bruke som kanskje mangler eller finnes kun på et overordnede nivå?
    b. Typisk målestokk for deres arbeid, eller oppløsning i modellene dere bruker?
20. Forholdene og forskjellene mellom de forskjellige kategori som brukes i flomsonekartlegging: aktsomhetskart, faresoner, risiko.
21. På en sjekkliste for reguleringsplan publiserte av NVE 11.06.2015 står det: "En avstandsgrense på 20 m fra bekker vil normalt dekke fare for flom og flomskred." Hvilke kriteria ligger bak dette råd?
    a. Gjelder dette under et klima i endring, med tanken at sosial infrastruktur har en brukstid på 50+ år og bolig kanskje 100 år?
    b. I reguleringsplan skal flomutsatte areal vises som hensynssone og tilknyttes bestemmelser som ivaretar sikkerheten gitt i TEK10 §7-2. Hvordan fungere dette i praksis?
22. Hvordan tilpasses kart til kommunenes behov ? Si litt om fremgangsmåter.
    a. Hva ønsker de å ha på kart som dere ikke har på malen?
    b. Hvilke (og hvem sine) skjønnsmessige vurderinger brukes is kartleggingen? Blir dette en tekniske øvelse eller mer et samarbeid?
23. En grense på kart fremstår ofte som veldig absolutt mens flomsoner er ganske gildene. Hvordan opplever brukere resultater av deres kart?
24. NVE gir innspill og uttalelser til overordnede planer. Kan du si litt om den generelle kvaliteten av ROS-analyser knyttet til slike planer?
25. Hva er de viktigste fordelene ved bruk av flomsonekart i arealplanlegging?
26. Hva er de viktigste begrensinger ved bruk av flomsonekart i arealplanlegging?

Slutt

27. Har du lyst til å si noe annet vi kanskje ikke har snakket om?
28. Er det noen andre du synes jeg bør snakke med?

Tusen takk!