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Data and processes linking vulnerability assessment to adaptation decision-making on climate change in Norway

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Abstract

The article focuses on the use of climate change vulnerability assessments in a local decision-making context, with particular reference to recent studies in Norway. We focus on two aspects of vulnerability assessments that we see as key to local decision-making: first, the information generated through the assessments themselves, and second, the institutional linkages to local level decision-making processes. Different research approaches generate different types of data. This is rarely made explicit, yet it has important implications for decision-making. In addressing these challenges we propose a dialectic approach based on exchange, rather than integration of data from different approaches. The focus is on process over product, and on the need for anchoring vulnerability assessments in local decision-making processes. In conclusion, we argue that there is unlikely to be one single 'correct' assessment tool or indicator model to make vulnerability assessments matter at a local level.

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1. Introduction

The increasing scientific certainty of human-induced climate change raises serious questions about the vulnerability of local communities. A key issue is how to improve adaptation to what appears as inevitable, yet uncertain, climate changes by using available information on climate change and societal vulnerability. Vulnerability assessments—systematic examinations of who is vulnerable, to what and why—are a widely used instrument, comprising a broad group of tools with varying characteristics and goals. Their origins lie in the areas of impact assessments, hazard research and food-security studies (Schröter et al., 2005; Patt et al., 2005); and their goals have over the past decade changed from mapping potential climate change impacts to an increased focus on strategies to facilitate adaptation (Füssel and Klein, in press).

The usefulness of vulnerability assessments for policymaking is, however, contested. Many concerns relate to the interface between researchers and stakeholders; the information vulnerability assessments can provide, and the ability of stakeholders to make use of it. Challenges discussed in the literature include: identifying user groups and their data needs; providing information that is salient, credible and legitimate; integrating data produced at different levels into meaningful information at the level of detail required by various stakeholders; and communicating uncertainty in climate scenarios (e.g., Cash et al., 2003; Aaheim and Schjolden, 2004; Moser, 2005; Jacobs et al., 2005; Patt and Dessai, 2005). There are many recommendations as to how to improve the use of vulnerability assessments. These include: involving stakeholders as active participants with agency, not merely passive recipients of information; involving users early in the process; combining users' own lay knowledge with expert knowledge; and using climate and socio-economic

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scenarios to actively enhance social learning (e.g., Schröter et al., 2005; Turner et al., 2003; Berkhout et al., 2002).

Building on the discussion of these topics in the literature, we address challenges for vulnerability assessments as an instrument for local-level adaptation. The local level is important as vulnerability is location-specific and because a large share of decisions affecting vulnerability are local (O'Brien et al., 2004a; Liverman and Merideth, 2002; Cutter, 1993, 2003). To illustrate challenges for locallevel adaptation, we use examples from recent research in Norway. O'Brien et al. (2004a) demonstrate that while Norway as a whole can be considered resilient, vulnerability is potentially high at regional and local levels because of economic structures, topography and infrastructure. Municipal governments in Norway are important in determining local vulnerability to climate risk as they are obliged to consider natural hazards in area planning under the Planning and Building Act, and could be liable in case of damages (Berg and Fergus, 2004; Ministry of the Environment and Ministry of Local Government and Labour, 1997).

Yet, while climate-related risks such as floods, storms and landslides figure prominently in planning guidelines for risk management at the municipal level (NVE, 1999; Ministry of the Environment and Ministry of Local Government and Labour, 1997), there has as yet been little focus on local adaptation to climate change in Norway. A number of municipalities have prepared climate and energy plans, but very few have made reference to adaptation. At the same time, an increasing number of national agencies (e.g., the Norwegian Water Resources and Energy Directorate, the Norwegian State Housing Bank) are developing their own plans to adapt their activities to climate change. Norway is thus an interesting example of a country where, in the absence (thus far) of a coordinated government adaptation strategy, outcomes at the local level depend on a combination of local initiatives and national-level, largely sector-based strategies. This in turn raises important questions as to how priorities for adaptation are set.

In this context, we focus here on two aspects of vulnerability assessments that we view as particularly important for local decision-making: the information generated through the assessments themselves, and the linkages to local-level decision-making processes. We discuss these in turn.

First, we examine (Section 2) the generation of data in vulnerability assessments. Two recent studies serve to illustrate the difference between vulnerability indicators based on descriptive, macro-level data and indicators developed from locally specific, interpretive information. By 'descriptive' we refer to quantitative studies that are characterized by viewing the local context from an outsider's perspective, whereas 'interpretive' implies more locally based studies aiming to look at the local context from an insider's point of view (Malone and Rayner, 2001). Different perspectives raise different sets of challenges, and the data complement each other. We find that different perspectives on the role of climate scenarios, the types of information included, and the processes for identifying vulnerable areas have important implications for the data produced, which in turn is a key factor for whether and how the information can be used at the local level. These latter aspects have largely been overlooked in studies in Norway.

Second, we discuss (Section 3) the institutional challenges in making use of assessments: in particular the local capacity to use information; the structural fit between assessment information and local policy processes; and the processes through which institutions may change in response to external stresses. It is clear that institutions are key to the use of assessment information. This issue has, however, received relatively little attention compared to the work on improving the validity of assessment information itself. We review work in Norway indicating that there exist institutional barriers to the active use of vulnerability assessment information.

Discussing the way forward (Section 4), we argue for more recognition that different analytical viewpoints have important effects on the types of questions are asked, the type of information generated, and the functions of such information for different groups of users. We propose a dialectic approach which is broad enough to include different perspectives and data, ranging from the natural sciences to different social sciences, as well as the local information held by the users themselves. Three key components of this approach are outlined: (a) a framework for identifying vulnerable areas, utilising the strengths of different viewpoints; (b) a focus on vulnerability assessments as a long-term process rather than a one-off assessment product; and (c) an emphasis on grounding the assessment in local processes, but without overlooking the national level. Section 5 provides conclusions as well as some reflections on the future development of local-scale assessment approaches in Norway.

2. Assessment information: scientific validity and local relevance

An important concern with vulnerability assessments is their ability to address issues that matter in a local context (Schröter et al., 2005). Scientists' framing of an issue may not be relevant to users' needs or the complex decisionmaking processes in a given location (Jacobs et al., 2005). We illustrate this challenge with two recent studies from Norway, one focusing on mapping of vulnerability based on uniform macro-level indicators (O'Brien et al., 2003), the other developing local vulnerability indicators and identifying linkages to national level indicators (Aall and Norland, 2004).

O'Brien et al. (2003) aimed at identifying factors that determine vulnerability at a municipal level, and in that way form a starting point for dialogue leading to local



Fig. 1. Maps showing exposure (left) and adaptive capacity (right) based on composite indices for agriculture as shown in Tables 1 and 2 below (adapted from O'Brien et al., 2003).

actions. The study, part of an effort to investigate the socio-economic implications of climate change in Norway, represented the first country-level mapping of vulnerability to climate change undertaken in Norway.¹ To assess different aspects of vulnerability, two sets of maps were created: one for biophysical exposure, highlighting the susceptibility to climate change from a natural resource management perspective, and one for social sensitivity and adaptive capacity, i.e. showing the societal ability to adjust to changes. The sectors of agriculture, forestry and winter tourism were chosen because of their sensitivity to climate change, as well as being among the economically most important for rural municipalities in Norway. Indicators were aggregated to a municipal level and put together in composite indices. Fig. 1 shows maps of biophysical exposure (left) and adaptive capacity (right) for the agricultural sector. For the exposure maps, key climate parameters expected to be important for the sectors were downscaled from climate scenarios² for the period 2030-2050, and compared to 1980-2000 (Table 1). The downscaling to municipal level figures was based on interpolation. The aggregate vulnerability index was calculated as an average of the individual indicators listed in the table. Indicators for the adaptive-capacity maps were based on social sensitivity to climate change as well as economic and demographic factors (Table 2). These three groups were given equal weighting in the aggregate adaptive-capacity indices.

A separate study by Aall and Norland (2004) started from a local point of view and sought to combine data from national level databases with locally specific data.³ Whereas O'Brien et al. (2003) highlight the differential vulnerability within Norway with the municipality as the lowest level of quantification, Aall and Norland (2004) explored the possibility of assessing variations also within the boundaries of a municipality. The authors explored how a local perspective could be added to vulnerability assessments in order to increase the validity of assessment data at the municipal level. The overall goal of the study was to create a vulnerability indicator model for local-scale assessment incorporating different sectors and vulnerability issues, relying on a flexible group of data sources, including as needed both quantitative and qualitative data. Their model sought to integrate data on biophysical (physical and biological) exposure, societal sensitivity, and adaptive capacity vis-à-vis climate change. Perspectives

¹Within the research project 'Climate change vulnerability in Norway: Socio-economic perspectives on policies and impacts' (2001–2005).

²Provided by RegClim, Regional Climate Development Under Global Warming (Phase III, 2003–2006), a coordinated research project with the aim to produce scenarios for regional climate change in Northern Europe, bordering sea areas and parts of the Arctic. Financed by the Research Council of Norway.

³Within the research project 'Climate Change in Norway: An Analysis of Economic and Social Impacts of Adaptations', and the sub-project 'Institutional Dimensions of Climate Adaptations', funded by the Norwegian Research Council.

Table 1								
Agriculture:	Indicators	of e	exposure.	Source:	O'Brien	et	al	2003

Indicator	Description	Justification
Spring precipitation	Monthly precipitation in April and May (mm change)	Increased spring precipitation assumed negative as it may cause delayed sowing, rot/fungus attack on seeds, and soil erosion.
Autumn precipitation	Monthly precipitation in August and September (mm change)	Increased autumn precipitation assumed negative as it may cause delayed harvesting, rain and wind damage, rot, and less time for soil preparation before the winter.
Length of growing season	Number of days per year with average temperature above $5 ^{\circ}$ C (no. of days change)	Longer growing season assumed beneficial as it may give higher yields, possibly more harvests, opportunities for new crop types, and longer pasture seasons.
Frost/thaw days, spring	No. of days per month in April and May with min. temperature below 0 °C and max. temperature above 0 °C in April and May (no. of days change).	Increased number of days in April–May with frost-thaw fluctuations assumed negative as it may cause soil disruptions and damage to yields.
Frost/thaw days, autumn	No. of days in September with min. temperature below 0 °C and max. temperature above 0 °C (no. of days change).	Increased number of days in September with frost-thaw fluctuations assumed negative as it may cause soil disruptions and damage to yields.
Average snow depth January, February, March	Average snow depth in January, February and March (no. of cm change)	Reduced snow depth assumed negative as it may lead to soil erosion, incomplete insulation for winter harvests (e.g. winter wheat), and it exposes plants to frost. Snow cover of 20 cm or less assumed insufficient.

Table 2

Indicators of adaptive capacity. Source: O'Brien et al., 2003

Social sensitivity	Economic factors	Demographic factors
Employment in the sector	Tax base Government budgetary transfers Employment forecasts	Age distribution Migration Dependency rate

on social vulnerability and institutional capacity were combined with both adaptation and mitigation-oriented policies. In the latter sense the model differs from most other vulnerability assessments, which tend to focus mainly on adaptation.

These two studies highlight important differences between vulnerability assessments starting from a macro level and those starting from a micro level. We discuss three areas in the following.

2.1. The role of climate scenarios

First, the studies demonstrate differences in the use of climate scenarios, and how this affects data generation. O'Brien et al. (2003) integrate climate parameters and downscaled climate scenario data in their mapping, on a par with current socio-economic and socio-demographic municipal level data. Aall and Norland (2004) emphasize the need for local indicators of what causes vulnerability, pointing to the fact that current climate scenarios have a

low predictive capacity at local level and thus limited local policy relevance. Whereas the focus of both studies is the same, i.e. indicators for local level vulnerability, the data they generate differ significantly, and their attitudes to climate scenarios vary. Aall and Norland (2004) stress the weaknesses that can be found in scenario-based approaches, in that they say nothing about how likely a certain scenario is, nor which of a given range of scenarios is most likely.

The two studies can be considered in the light of developments within the climate change research over the past decade. Originating from a natural science based approach, vulnerability assessments have traditionally been closely linked to climate scenarios. Early vulnerability assessments assumed a more or less linear cause-effect relationship from global developments to greenhouse gas (GHG) emissions, and climate change at global and regional levels (see e.g., Carter et al., 1994a,b). Increasing resolution of climate models allowing a more fine-grained analysis have provided a better foundation for studies at a sub-national and local level, but it has also led to important debates highlighting the differences in views among different research approaches and disciplines.

Debates concern how to represent uncertainties, different views on uncertainties, and different approaches to how to manage them in assessments. An alternative approach has emerged, focusing on the factors that shape vulnerability, using current or recent climate events as starting points. This has been accompanied by a growth in local level case studies where the main focus is on identifying the local factors that determine vulnerability, and hence where climate scenarios play a smaller role (Dessai and Hulme, 2003). Vulnerability is here seen as a function of exposure, sensitivity and adaptive capacity, generated by multiple factors and processes (O'Brien et al., 2004b).

In Norway, these differences are demonstrated by the use of climate scenarios between on the one hand, the RegClim project that produces scenarios, and the downstream users on the other. Uncertainties are highlighted by RegClim, and it is stressed that regional scenarios are sensitive to small changes in input factors. Norway's topography gives particular challenges to regional (subnational) level scenario development. For example, small changes in wind directions have major effects on predicted rainfall patterns. The RegClim project are focusing on improving climate scenarios, validating them in view of recent climatic events to provide as accurate a picture as possible. The experiences from the Norwegian studies, however, show that while climate scenarios are seen as important for the establishment of local attention and interest, the local level acknowledgement of the situation is related to variations and nuances in vulnerability predictions that only locally specific data can provide.

2.2. Local relevance of vulnerability indicators

A second area where the assessment approach is important is the local relevance of vulnerability indicators. How can vulnerability indicators assessments meaningfully represent the local situation? And how are different types of knowledge considered? What outsiders (including climate change researchers) deem most important might not be viewed as most important locally, and finding indicators that reflect local concerns and decision-making processes is a key challenge (Jacobs et al., 2005). Assessments based on uniform indicators for a whole region may miss out local complexity and lead to too general conclusions about local scale vulnerability. At the same time, it seems clear that locally anchored assessments can result in misleading conclusions by overlooking the implication of regional- or national-scale patterns and processes (Wilbanks, 2004; Wilbanks and Kates, 1999).

In the context of Norway, O'Brien et al. (2003) argue that assessments will only be valuable once stakeholders affirm them at the local level. Aall and Norland (2004) question whether it is possible to formulate a standard set of vulnerability indicators because of the lack of knowledge-perhaps in many cases better described as lack of local specificity-about key causal mechanisms. For example, effects of an increase in rainfall in agriculture will depend on land use. In the Eastern parts of Norway, a relatively small increase in rainfall may increase erosion manifold as the dominant land use is annual crops where soils are exposed parts of the year, whereas in the Western part, with land use dominated by animal husbandry, effects of a larger increase in rainfall may be smaller as the land is grass-covered throughout the year. Aall and Norland (2004) further argue that even in areas where knowledge exists, it will be difficult to determine how effects will be distributed locally and regionally, and how intense these effects will be. Another question concerns possible effects of interaction between single effects. How can vulnerability indicators capture these? Such effects will likely be unexpected, in the sense of being unpredictable as to both extent and outcome. Interactions could even lead to substantially new effects, and thereby alter the initial conclusions on vulnerability.

The experiences from dialogues with local stakeholders described in O'Brien et al. (2003) confirm scepticism to the local usefulness of uniform vulnerability indicators. Both municipal officers and other sector interests requested topographically more sensitive scenario data and better local specificity on sector activities and related causal factors. Aall and Norland (2004) suggested the use of system-based local-level assessments to better grasp local reality. This highlights a role for local actors and experts to identify local causal mechanisms and possible effects of interaction, and make use of scale-specific information/ data (quantitative and qualitative, informal local knowledge and experience). Local actors are first of all seen as receivers of information, but this perspective emphasises that local stakeholders and experts are also providers of information. Internationally there is an emerging interest in how local knowledge can be used to inform climate change vulnerability assessments, notably in the Canadian Arctic (e.g., Ford and Smit, 2004, ACIA, 2004). There has been little focus on this so far in Norway, but some recent studies suggest that while much local knowledge exists at the local level, for example in the areas of building techniques and land use planning, it is often not used in formal assessments and it is often omitted from formal guidelines (Lisø et al., 2003; Næss et al., 2005).

2.3. Identifying vulnerable areas

The work by O'Brien et al. (2003) and Aall and Norland (2004) also differ in a third important respect, namely the process through which vulnerable areas are identified. It is clear that identification of the areas that are most vulnerable to climate change is an important part of any vulnerability assessment, in order to help channel limited resources to where it is most needed, to demonstrate what climate change means in practice, and to facilitate



Fig. 2. The relationship between descriptive (top-down) and interpretive (bottom-up) assessment approach (Aall and Norland, 2004).

Table 3 Vulnerability matrix for classification of municipalities due to vulnerability and capacity for mitigation policies and climate change (Aall and Norland, 2004)

Response: Institutional capacity	Vulnerability: Biophysical exposure and social adaptive capacity				
	Low vulnerability	Low vulnerability	High vulnerability		
High for climate measures and adaptation High for climate measures or adaptation	Low risk	Moderate risk			
Low for climate measures and adaptation			High risk		

processes to place climate change in its appropriate societal context. How the identification is made, however, is important for how climate change is considered and its significance in a decision-making framework.

O'Brien et al. (2003) use composite indices as described above to arrive at a ranking of vulnerable areas. Aall and Norland (2004) address the strengths and weaknesses of both an aggregate national-level approach and a local-level indicator approach by suggesting the integration of the two approaches in a two-step model for local-scale assessment, as shown in Fig. 2. The model springs from the arguments that: (1) local level assessments are resource demanding; and (2) a potential overestimation of the role of climate change in one place might reduce the credibility of such discussions in more vulnerable local communities, and for those reasons the number of local level assessments should be limited.

They use a set of indicators that are uniform for the whole country, as developed by O'Brien et al. (2003), which provides a basis for ranking municipalities by local vulnerability. By feeding the results of such an assessment for each municipality into a 'vulnerability matrix' (as shown in Table 3), an initial vulnerability profile of the municipalities can be identified. In this view, vulnerability is a function, on the one hand, of the climate effects on natural and societal processes, and, on the other, of the local institutional capacity to handle the changing situation. The purpose of the 'matrix' is to identify the most vulnerable communities and sectors. A ranking of municipalities would, in this framework, represent a basis for national discussions on the actual need for a climateadaptation policy in Norway, resting on the ability of the scenario-based descriptive approach to identify national 'extremes' of risk that are likely to be veiled in nationalscale assessments (O'Brien et al., 2004a). Local vulnerability assessments could then be primarily carried out for 'high-vulnerability' municipalities: those municipalities identified as having high risk for climate effects on natural and societal processes, in combination with low institutional capacity for mitigation and adaptation.⁴ Aall and Norland (2004) introduce three different types of indicators for local-level assessments: (1) Adjustment of the uniform indicators to incorporate local knowledge and experience, or more technical considerations; (2) additional quantitative indicators based on locally collected data; and (3) more ad-hoc nominal measures to both capture specific local relationships and map vulnerable areas and installations.

The major principle to emerge from the above findings is that the two different assessment approaches represent different choices on the flexibility and variation in the knowledge base, as well as the methodological constraints that are put on the selection process. Aall and Norland (2004) placed local authorities at the core of the assessment process because of their strategic position between local actors, external experts and the local institutional constellations.

⁴ Capacity for mitigation' refers to the capacity of local institutions to undertake nationally or internationally requested mitigation measures.

3. Connection to local decision-making: institutional challenges

We now turn to the relevance of climate data to a decision-making context, increasingly seen as a crucial factor for their practical utility (Cash et al., 2003; Patt et al., 2005; Jacobs et al., 2005). Several recent studies have looked at institutional aspects of climate adaptation in Norway, from different angles (Aall and Groven, 2003a; Lindseth, 2005: Næss et al., 2005). Institutions have been considered in relation to their role in determining vulnerability, as expressions of power of different social groups, and in terms of their ability to change and adapt in response to climate change or other external perturbations. Three issues that have emerged as important for whether and how assessments can be used are: (1) institutional capacity and structures and their impact on the capacity to handle information, as well as the incentives they provide for action, (2) the communication of the climate change and people's perceptions, and (3) the ability of institutions to learn and change. These are discussed in the following.

3.1. Institutional capacity and structures

Local level institutional capacity is closely related to both the demand for and ability to use information at a local level. Studies in Norway suggest that having a municipal level environmental officer in place is an important factor behind the level of engagement of municipalities in environmental policies (Bjørnæs, 2002). There are a number of key institutional structures and policy instruments in place at municipal level, including municipal land-use planning integrating perspectives on exposure to natural hazards, Risk and Emergency Plans, and Climate and Energy Plans.

Aall and Groven (2003a) demonstrate through a review of four key institutional systems in Norway that concern about adaptation is weakest within the local environmental policy sector. Institutional systems related to land-use planning, civil defence, risk management, and insurance have all begun addressing the impacts of climate change and potential adaptation measures, though thus far primarily at a conceptual and theoretical level. This indicates that the established sectoral structures, policies and interests are potential barriers for a comprehensive integration of adaptation perspectives in local policies. However, it also points to possible benefits from a broad scope of vulnerability assessments as the foundation for the integration of adaptation as a perspective within the existing institutional systems. Locally-based interpretive assessments have a particularly important role to play in framing climate change in a broad societal context, defining indicators across sectors and areas, and formulating information on vulnerability in a format that fits the existing policy instruments and structures.

At the same time, Norwegian municipalities are currently facing considerable budget constraints, as evident in the decline in resources allocated to environmental issues, whether for projects or administrative staff (Bjørnæs, 2004, 2002). Studies of recent climate events in Norway suggest that existing municipal institutional arrangements provide few incentives for proactive adaptation at the local level (Næss et al., 2005; Groven, in preparation). When conflicts over priorities arise—as they usually do in local governance—short-term pressing issues are likely to be given priority at the expense of more long-term considerations (Aall and Groven, 2003a). A key challenge is thus to address climate vulnerability in a way that the information fits existing structures.

By establishing local authorities as key actors in locallevel assessments, the potential for an optimal 'fit' between information supply and the municipal institutional system may be strengthened. At the same time, a local-level focus and implementation is no guarantee for success. Risk and vulnerability analyses undertaken at the local level in Norway often appear to be done from a sense of duty rather than perceived usefulness, and are to a large degree carried out by external consultants (Aall and Groven, 2003a). Local-level follow-up to such plans is often weak and poorly integrated into other activities in the day-to-day activities of the municipalities (Agenda, 2002). This indicates a clear need to pay attention to institutional structures across governance scales, and to an acknowledgement that a multi-level approach to vulnerability assessment can significantly contribute to increasing effectiveness.

3.2. Communication with stakeholders

There is ample evidence that the communication process is a crucial part of making vulnerability assessments relevant and operational in a local context. Dissemination and dialogue, as well as refining methodologies in accordance with changing information, are stressed by several authors (O'Brien et al., 2003; Lorenzoni et al., 2000a,b; Lemos and Morehouse, 2005; Jacobs et al., 2005). Communication processes determine the interpretation of information and lay the foundation for further action.

In Norway, dissemination of scenario-based climate change assessments to stakeholders is in its infancy. The research project for climate-scenario development in Norway (RegClim)⁵ does not have a mandate for dissemination beyond the research community. One of the first workshops focusing on dissemination of scenarios to stakeholders (defined in this case as government agencies, research institutions and private firms) was held by the Norwegian Meteorological Office in October, 2004.⁶ Focus-group discussions in two municipalities as described in O'Brien et al. (2003) provide one of the first efforts to discuss scenario-derived information with municipalities.

⁵See Footnote 2 above.

⁶See http://met.no/met/klima/seminar2004/index.html (in Norwegian, accessed 15 February 2005).

As indicated above, they also highlight key challenges. O'Brien et al. (2003) present the vulnerability maps as a starting point for dialogue, highlighting scenario uncertainties, but responses indicate that the maps were often interpreted as if they represented the most likely future outcome. One municipality was particularly critical to being labelled as vulnerable.⁷ A similar problem occurs in the area of seasonal weather forecasts. These are probabilistic, but are commonly interpreted deterministically; that is, as shortterm weather forecasts (Goddard et al., 2001). Aall and Norland (2004) emphasize that locally anchored approaches would ensure that terms and concepts used in the assessment would follow local standards and connotations.

Another challenge concerns channels and entry points of communication. Climate change has traditionally focused on mitigation and been framed as an environmental issue in Norway, and has thus been the domain of the Ministry of Environment, its directorates and county-level offices, along with the environmental officers at the municipal level. The decline in the number of municipal environmental officers (Bjørnæs, 2004, 2002) not only implies a clear loss of capacity to address climate change locally, but also a loss of local-level entry points for communication and action. Increasing limitations on municipal budgets also implies that a "new" (i.e. perceived as new) issue such as vulnerability to climate change will easily be given low priority-or even ignored in political discussions. The appropriate channels of communication may thus vary in accordance with how local institutions are set up, and strategic actions may be as important as technical linkages. For example, we argue below (Section 4) that in cases where municipalities have already conducted climate and energy plans, it would make sense to link them to vulnerability assessments.

3.3. Institutional learning and change

How do institutions learn and change? Young (1998) stresses the importance of institutional flexibility and the ability to change in view of new information. New knowledge from vulnerability assessments may provide an external push for local institutional learning. However, institutional change takes place in a complex social environment, where new scientific knowledge is but one factor (Berkhout and Scoones, 1999). Local-level interpretive studies may act as a pull factor for institutional change through their emphasis on local processes, ownership and locality-specific needs for data. Adger (2000), for example, discusses how institutions can change in response to demands from civil society, in an effort to maintain their legitimacy.

Recent studies in Norway suggest that overall, there has been limited institutional adaptation at the municipal level in response to recent large-scale climate events such as a major hurricane in 1992 and floods in 1995 (Næss et al., 2005; Groven, in preparation). This may partly be ascribed to institutional disincentives for taking proactive measures. Local-level actors, notably municipal governments, may be reluctant to take on investment costs in a situation where the central government has been generous in covering costs of climate-induced damages in the past (Næss et al., 2005). The existing insurance system related to climate-induced events and natural hazards is also based on a long-standing principle of evening out insurance costs across the country, independent of local differences in the potential risk (Aall and Groven, 2003a). Finally, the solutions defined and decisions made reflect the power relations and the dominant management mindset in municipalities. For example, flood management in Norway has traditionally had a bias towards large-scale, one-off technical infrastructure measures (such as constructing flood barriers), coinciding at the local level with the economic and political interests of agriculture and property owners in flood-prone areas (Næss et al., 2005). The local perspective on risk management appears, in other words, to lack integration across sectors and risk categories.

Increased costs of climate-related hazards may in the long run drive institutional change. Municipalities are receiving increasing formal responsibilities for land-use planning, and insurance companies have started taking them to court to claim compensation for insurance costs when damages result from poor land-use planning, for example when municipalities allow development in areas with a high probability of damage caused by flooding, avalanches, or landslides. Vulnerability assessments could in this way be a key instrument for municipalities, and may pave the way for integrating climate change perspectives in local governance.

4. Discussion: the way forward

The review above demonstrates the complexity involved in vulnerability assessments and the challenges in combining different approaches. It suggests that there are significant differences in how different standpoints frame an issue, in the data outcomes produced, and in the fit with decisionmaking frameworks. The different approaches span different epistemological positions involving variations in how knowledge is perceived and what constitutes scientific validity, which suggests that they are not readily combined in a common integrated framework. In the following, we propose instead to focus on three issues: (a) linking of macro- and micro-level assessments in a dialectic process; (b) focusing on 'process over product'; and (c) combining adaptation and mitigation within vulnerability assessments.

4.1. Towards a dialectic approach to local-scale assessment

This section discusses the implications of the key elements of the Norwegian discourse with regard to placing

⁷Article in Norwegian newspaper: Adresseavisen http://www.adressa. no/nyheter/sortrondelag/hoyrespalte/article41798.ece (in Norwegian, 05.11.2003).

Table 4

The development of adaptation policies at different levels and scales: information needs and relative strengths of descriptive and interpretive assessment approaches

Level of government	Types of information needs	Assessment approach			
		Descriptive (national level data)	Interpretive (local level data)		
National	 Information for initiation of national discussions and awareness rising Information for the development of national adaptation/ mitigation policies and priorities 	 National ranking/overview Identification of vulnerable sectors, social groups, geographical areas 	 Knowledge about causal mechanisms and interplay effects Identification of local needs for national policies 		
Local	 Information legitimate for local discussions and awareness rising Fit between the scales of information and local institutions Integrated information, across sectors and risk categories 	• Local vulnerability put in national perspective	 Transparent and inclusive assessment process Information in the form of local 'vulnerability maps' 		

issues of climate-change vulnerability and adaptation more firmly on the local policy agenda. Table 4 summarizes what we perceive as the roles of the different approaches to assessments represented by O'Brien et al. (2003) ('descriptive') and Aall and Norland (2004) ('interpretive'); and how they can provide different information for different levels and stakeholder groups.

While the local level of government clearly will gain from information on the potential vulnerability across sectors and risk categories, the (sectoral) national level of government is more likely to make use of more clear-cut risk scenarios as the starting point for governmental efforts. Both types of assessment approach can identify vulnerable sectors and areas, but they provide different answers. They are complementary in the sense that they seek to integrate different kinds of data and methods of local-scale analysis. One question is whether these approaches essentially target different levels of government, making it difficult for them to be relevant across scales. The applicability of community-based local-scale assessments to other areas, or to higher levels of social organization, has been questioned (Cash and Moser, 2000); and some are sceptical as to how useful aggregated indices provided by macro-level assessments are for local stakeholders (Adger et al., 2004; Downing and Patwardhan, 2004). Another issue is whether integrating the two approaches would bridge the gap between the different types of vulnerability assessment and the different types of information they provide. Existing literature within this field remains vague as to why an integrated approach would be better and on how to integrate in practice. Malone and Rayner (2001) are strictly opposed to attempts to meld descriptive (data from national level databases) and interpretive (local level data) assessments; although they emphasize the need to bring the two together to supplement the respective deficiencies in the models: "The dimensions of climate change simply cannot be adequately addressed without using both approaches" (Malone and Rayner (2001, p. 178).

We argue that the model proposed by Aall and Norland (2004) establishes a basis for understanding the integration of descriptive and interpretive perspectives as a *dialectic* process, where information from the two approaches is not so much *integrated* as *exchanged*. The dialectic aspect of the model implies a transfer of information and perspectives on climate vulnerability across scales and levels. For example, a descriptive mapping of local-scale vulnerability can reveal how vulnerability varies across the country, as well as the extent of the challenges the country might be faced with from a changing climate. In the local context, a national ranking could also trigger local discussions. If a municipality is given a relatively high vulnerability-ranking, for example, it may lead to critical debates over the implications of such labelling, and its fit with local realities. Interpretive assessments would, in such cases, lead to different insights into causal mechanisms and vulnerability that could in turn supplement information from the descriptive approach by presenting detailed examples of local-scale impacts which would also be useful in national adaptation policy discussions.

The dialectic approach can thus also be understood as a way of strengthening communication and awarenessraising across levels of government. The development of local adaptation processes will require dialogue and coordination at various levels. Experiences from Local Agenda 21 (LA21)⁸ processes and municipal-level GHG emission-reduction initiatives in Norway provide data on the importance of differentiating between national and local initiatives in this area (Lindseth and Aall, 2004; Aall and Groven, 2003b). The reduction of national support for local processes that take on perspectives beyond traditional

⁸Local-level follow-up of the Agenda 21 from the UN conference on Environment and Development in 1992.

local environmental issues has led to an evident stagnation in local-level initiatives. It is hard to envision the development of local climate-adaptation capacities without a substantial parallel national effort. The issues of risk and precautionary measures that local communities face in the area of climate change require a strong and binding cooperation across sectors and levels. A dialectic assessment process might serve to support the development of a multi-level climate policy, as it has the potential of identifying national challenges and local barriers for the development of adaptation strategies. Run as parallel processes, a combination of descriptive and interpretive approaches in the form of a two-level dialectic process can represent a common framework for dialogue between stakeholders as well as levels of government.

A shift in emphasis from descriptive to interpretive assessments could, in fact, be relatively critical, since descriptive assessments can come to different conclusions from interpretive assessments (Aall and Norland, 2004; Wilbanks, 2004). The ability to mobilize local resources for conducting local assessments would, however, depend on the overall initial conclusion. Again, a key feature of the proposed approach is a more balanced scientific assessment as a point of departure for more judicious and effective local decision-making. As suggested by Aall and Norland (2004), local assessments can serve to either confirm or weaken the initial classification of 'high vulnerability' municipalities, and subsequently represent a strategy for initiating local discussions and formulating local-adaptation strategies if deemed necessary. The important point is that interpretive assessments can be vital for providing a more substantial and locally grounded input to local policy-making.

4.2. Emphasizing process over product

Most assessments of climate change vulnerability and impacts in Norway have been explicitly or implicitly 'product-oriented'; that is, focused on outcomes that aim to assist stakeholders in planning adaptation to climate change. External researchers or consultants have commonly carried out even local-level assessments, and the actual involvement of local stakeholders has been at best arbitrary. Based on the above discussions, we argue that assessments need to focus more on a process of collaboration with local stakeholders.

First and foremost, this is (as noted above) because it is difficult to develop a vulnerability assessment that gives sufficiently detailed answers for local action over a short period of time. Availability of formalized data is limited with regard to the ability to predict future vulnerabilities. The primary role of the interpretive assessment would thus be to establish local-level discussions, which in turn can lead to local ownership, helping to identify potentially vulnerable actors, sectors and areas, and contribute to improved institutional capacity. Such local processes can also generate genuine local data, as well as verify the quality of the down-scaled national data provided by the descriptive assessments. Much local knowledge exists among stakeholders, but descriptive assessments tend to underplay local knowledge and perspectives. The involvement of stakeholders in the design and undertaking of vulnerability assessments means that the assessment is not only more directly tailored to grasp the local situation, but that stakeholders will see the results as relevant and acceptable (Bäckstrand, 2002). This could pave the way for more effective policy debates by facilitating integration across sectors and ultimately enhancing acceptance for local use of resources in priority areas. Labelling an area as 'vulnerable' has many implications, and may backfire unless the criteria used are transparent and locally accepted. In other words, the involvement of stakeholders in the process has a legitimating value in and of itself, irrespective of outcome.

Second, undertaking interpretive assessments as local processes can help to adapt changing scenarios to the local situation. Local stakeholders can act as mediators for information from higher levels of government. The ability of descriptive assessments to identify the regions and municipalities most vulnerable to change depends on the refinement of the input data. Uncertainties will, however, always remain in the scenarios, and varying communications of continuous changes in predictions over time (due to scenario development) could undermine stakeholders' trust in the outputs. Downscaled scenarios can, for example, be expected to vary considerably with different global circulation models (Iversen et al., 2003). Moreover, local actors would not necessarily know what climate scenarios actually communicate and how they can be explored in a local community. This indicates the importance of communication between local actors and scientists as part of the assessment process.

Third, concerning policy change, a broadened stakeholder involvement will also serve to identify institutional entrypoints for cross-sectoral local adaptation policies. As discussed above, local authorities would have a key role to play in local assessment processes, thereby increasing the potential for an optimal 'fit' between information supply and the municipal institutional structures. For example, local vulnerability presented in the format of local 'risk maps' could increase the potential of integration of adaptation perspectives in existing land-use planning (Aall and Norland, 2004). Caveats here include the question of whether external experts would make the same kinds of assessments as the local stakeholders. It cannot be assumed that local communities will give the same weighting as experts trying to establish scientific criteria for vulnerability (Stephen and Downing, 2001; Villa and McLeod, 2002). Many crucial local processes are also likely to be mediated by local power structures and dominant stakeholders (Næss et al., 2005).

4.3. Combining adaptation and mitigation in a vulnerability assessment

The vulnerability assessment model by Aall and Norland (2004) tries to combine the perspectives of both adaptation

and mitigation. The authors argue that such a combination as part of local vulnerability assessments is important for three main reasons: the possibility of creating mutual legitimization within the mitigation and adaptation policy areas; the strong interactions between mitigation and adaptation measures; and the need for sector integration and cohesion.

Studies show that a focus on climate adaptation may increase support for mitigation-oriented measures (Burton et al., 2002). Wilbanks (2003) argues, however, that it is easy to overestimate the role of the damage that climate can cause and similarly underestimate the potential of climate change to act as a catalyst for more sustainable policies. The danger of overestimating the role of climate impacts is that it could damage the credibility of otherwise legitimate arguments. Regardless of potential effects of interaction or synergy effects, climate mitigation could be an *entry point* for the introduction of climate adaptation to the local policy agenda, as mitigation already exists as a policy field in many local communities in Norway. The combination of mitigation and adaptation perspectives has been virtually absent in Norway (Lindseth, 2003; Aall and Groven, 2003b). Many municipalities have formulated local 'Climate and Energy Plans' that focus on mitigation, but very few of these have included any consideration of adaptation.⁹

Further, LA21 processes have to some extent included perspectives on mitigation, such as energy and transport reducing efforts, and alternative energy sources (Bjørnæs, 2004). Bjørnes and Norland (2002) found that better integration of LA21 processes in the overall local management and municipal policies tends to increase integration of global environmental perspectives. The extent of localmitigation efforts is closely related to whether the local authorities have managed to establish a link to existing local challenges, such as local environmental problems or economic stagnation (Lindseth and Aall, 2004; Bjørnæs and Norland, 2002). Local problems are used as 'door openers' for the evolvement of local climate policies. Locallevel interpretive assessment processes can identify links between present local interests and challenges, and relevant mitigation and adaptation efforts. An important nuance here, however, is that-depending on the local context-it might be more difficult to introduce adaptation if it is associated with a mitigation agenda, especially in areas relying on emission-intensive industries.

Linking mitigation and adaptation in a local context may increase the possibility of revealing potential effects of *interaction* between mitigation and adaptation measures. Mitigation measures can increase local vulnerability to climate change, and measures for adaptation can likewise increase the local emissions of GHG (Aall and Groven, 2003a)—unless they are discussed together. For example, efforts to reduce GHG emissions could include the concentration of housing development close to the town centre, while an adaptation strategy could dictate that if the town centre is located close to a river prone to flooding it would be desirable to locate new housing sufficiently far away from the centre. Local dialogue processes have the potential also for identifying *synergy* effects among local measures that subsequently could be used actively to mobilize local actors. Identification of potential conflicts and synergies would thus be of clear relevance for giving climate change the appropriate emphasis, and such discussion can further help guide policymaking toward the most exposed and potentially vulnerable areas, sectors and social groups in a twofold sense.

Mitigation has usually been framed as an environmental issue within the domain of local environmental officers. Mitigation efforts have commonly focused on the 2-3 leading sectors for greenhouse-gas emissions within a given municipality. By contrast, adaptation would be broader and more complex, affecting "all" sectors and activities. Framing the problem as an environmental issue can tend to marginalize the issue in areas where it might otherwise naturally belong. While local mitigation plans can be useful as an entry point, the focus needs to be expanded to reflect a wider coverage. Integrative perspectives and institutional changes at higher levels of government can in this context facilitate local-level integration. It further requires coherence between national and local perspectives on vulnerability to both climate change and climate policies. This again highlights the key role of local authorities. In practice, local authorities are often given the task of coordinating conflicting interests and sectors, and a resolution of these conflicts will be crucial in a climatepolicy context.

5. Summary and concluding remarks

In this article, we have discussed challenges for vulnerability assessments as an instrument for local-level adaptation, using examples from recent work in Norway. We first examined how data is generated with reference to two types of assessment: the work of O'Brien et al. (2003) on mapping vulnerability in Norwegian municipalities, and the study by Aall and Norland (2004) seeking to identify local-level vulnerability indicators. Different perspectives on the role of climate scenarios, the types of information included, and processes for identifying vulnerable areas have important implications for the data that are produced. This in turn is a key factor for whether and how the information can be used at the local level. Secondly, we looked at the institutional challenges involved in making assessment information relevant to local decision-making processes, focusing on the institutional capacity and structural fit, and processes for institutional learning and change.

⁹A total of 33 municipalities and 7 counties have since 2000 participated in a national pilot program on local climate policies run by the State Pollution Control Agency and received financial support for the development of local plans.

We have argued that vulnerability assessments could usefully be seen as a dialectic process, where different approaches provide different types of inputs to a vulnerability assessment; contribute to creating space for many types of data to be produced for stakeholders with different data needs; help to identify priority areas for further investigation; and, crucially, frame the assessment in a local context. We further argue for complementary approaches that capture different aspects of vulnerability, and for viewing vulnerability assessments as a process rather than a product.

It is important to caution that there is unlikely to be one single 'right' assessment tool or indicator model that can make vulnerability assessments matter at a local level. We have, however, highlighted the fact that different approaches can arrive at different conclusions on local vulnerability and adaptation needs, depending on the data used and how it is analysed. We argue that the complexity of assessing local climate vulnerability calls for greater efforts to bring various methodologies in under a common framework without necessarily aggregating them into one common index, and to view the local level as much as a provider of information as a receiver of climate or vulnerability data.

Local vulnerability is not only a function of single effects, but of interactive effects related to the interplay among single effects: an interaction that can alter the initial vulnerability profile. In a local context the different processes are inevitably interlinked. A multi-disciplinary approach to local-level assessment is thus a basic requirement for the evolvement of local adaptation policies and strategies beyond traditional local risk management. The review from Norway suggests that more work is needed in this area, as there is as yet no sectorally integrated adaptation strategy across levels of governance, and effective stakeholder involvement has been poorly developed. The approach we propose highlights that the critical aspect of uncertainty in this area of research is a major reason for developing a broader and more integrated methodological framework; a framework that in turn can provide a better point of departure for a more inclusive and consequential science-society dialogue. The approach thus calls for the involvement of a wide spectrum of local stakeholders, as well as external experts in local-level discussions, with local authorities assigned a key role in bridging the gap between the evolving perspectives on local vulnerability and the local institutional set-up.

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