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What's in a word?

Conflicting interpretations of vulnerability in climate change research

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Tittel: What's in a word? Conflicting interpretations of vulnerability in climate change research

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Sammendrag:. Denne artikkelen diskuterer to ulike tolkninger av konseptet sårbarhet i klimastudier og peker på hvilke konsekvenser disse forskjellige tolkningene har for forskning og politikkutforming. I den første tolkningen, beskrevet her som 'endepunkt-tolkningen', er sårbarhet et restprodukt av effekter skapt av klimaendringer og tilpasning til disse. I den andre tolkningen, derimot, er sårbarhet et 'startpunkt' og ses på som (en karakteristikk) et karaktertrekk? eller tilstand generert av forskjellige faktorer og prosesser. Endepunkt-tolkningen tilsier at sårbarhet er en avhengig variabel, bestemt av tilpasning og tilpasningskapasitet. I henhold til et startpunkt-perspektiv er det sårbarhet som bestemmer tilpasnings¬kapasitet. De praktiske konsekvensene av forskjellene mellom disse to perspektivene illustreres for Norge og Mosambik. Vi viser at dersom de underliggende årsaker til sårbarhet ignoreres er det en fare for å undervurdere alvoret av klimaendringer, de sosiale og miljømessige rekkeviddene av disse endringene samt hvor mye det haster å finne løsninger på klimaproblemet.

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Abstract: In this paper, we discuss two competing interpretations of vulnerability in the climate change literature and consider the implications for both research and policy. The first interpretation, which can be referred to as the "end point" approach, views vulnerability as a residual of climate change impacts minus adaptation. The second interpretation, which takes vulnerability as a "starting point," views vulnerability as a general characteristic generated by multiple factors and processes. Viewing vulnerability as an end point considers that adaptations and adaptive capacity determine vulnerability, whereas viewing vulnerability as a starting point holds that vulnerability determines adaptive capacity. The practical consequences of these two interpretations are illustrated through the examples of Norway and Mozambique. We show that, if the underlying causes and contexts of vulnerability are not taken into account, there is a danger of underestimating the magnitude (large), scope (social and environmental) and urgency (high) of climate change.

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1 Introduction

After three assessment reports carried out by the Intergovernmental Panel on Climate Change (IPCC), vulnerability has found its place in the climate change lexicon, with both natural and social scientists eager to measure and assess vulnerability, whether from the perspective of regions, sectors, ecosystems, or social groups. The IPCC Third Assessment Report (TAR) considers climate change vulnerability to be a function of exposure, sensitivity, and adaptability (McCarthy et al., 2001). Through this broad framework, the meaning of vulnerability has swelled to engulf notions of risk, impacts, and adaptability. In a field where scientists are simultaneously working to determine the nature and extent of the problem, identify the consequences, and address it politically, vulnerability serves as a flexible and somewhat malleable concept that can engage both research and policy communities. Yet the extensive use of vulnerability in the climate change literature hides two very different interpretations of the word, and two very different purposes for using it.

On the one hand, vulnerability is sometimes viewed as an end point – that is, as a residual of climate change impacts minus adaptation. Here, vulnerability represents the net impacts of climate change; it serves as a means of defining the extent of the climate problem and providing input into policy decisions regarding the cost of climate change versus costs related to greenhouse gas mitigation efforts (Kelly and Adger, 2000). On the other hand, it is sometimes viewed as a starting point, where vulnerability is a characteristic or state generated by multiple environmental and social processes, but exacerbated by climate change (Kelly and Adger, 2000). In this case, vulnerability provides a means of understanding how the impacts of climate change will be distributed, primarily to identify how vulnerability can be reduced.

The differing interpretations can be considered an unsurprising outcome of the wide breadth and scope of climate change research, and the fact that diverse scientific communities representing physical, biological, and social sciences and humanities are involved in addressing a very complex issue. Indeed, there are a number of words and concepts within the climate change literature that are conflated, vaguely defined, or imprecise, leading to confusion and misunderstanding among the research and policy communities, as well as the public in general. Vulnerability, adaptability, coping, risk, and environmental justice represent some of the most conspicuous cases, and there is a growing body of literature that addresses their varying definitions and approaches (Smit et al., 2000; Kelly and Adger, 2000; Downing et al., 2000; Burton et al. 2002; Füssel and Klein, 2002; Ikeme, 2003; Brooks, 2003). The clarification of these concepts is essential to designing and implementing research, to presenting the issue of climate change to a broad audience, and to addressing it through policies and responses.

We make the case in this paper that the two interpretations of vulnerability – as an end point or as a starting point – confound the issue of climate change. Rather than being merely a question of definitions or semantics, the interpretation of vulnerability has consequences for how climate research is carried out within interdisciplinary research institutes, where scientists with differing backgrounds often use terminologies that are vaguely defined and lack shared meanings. More importantly, it has major implications for how the issue of climate change is addressed by policy makers. In other words, the two definitions not only result in two different diagnoses of the climate change problem, but also two different kinds of cures.

Below, we explore these two interpretations in more detail. We look systematically at how they differ in terms of content (their definitions, contextual backgrounds, and key assumptions), as well as how they differ in consequences – specifically, how these differences affect both the “diagnosis” and the “cure.” We argue that the interpretations of vulnerability are closely linked to differing interpretations of adaptive capacity; that is, whether adaptive capacity refers to the ability to carry out specific technological adaptations to climate change or whether it refers to the ability to adjust to changing environmental and socioeconomic conditions. To illustrate the practical consequences that interpretations of vulnerability have for climate change policy and response, we look at the examples of Norway and Mozambique, countries with stark differences in material standards of living and social and economic development. We conclude that although it has been necessary and useful to view vulnerability as an end point, there is a need to begin addressing adaptation in both developed and developing countries through the enhancement of adaptive capacity. To do this, a shift to viewing vulnerability as a starting point is essential.

2 One word, two interpretations

Part of the challenge tied to the use of vulnerability in a scientific context and the development of a vulnerability science is that the word "vulnerability" is familiar in everyday language. This means that most people have a working understanding of vulnerability.[1] Although the word "vulnerability" is not particularly precise in everyday usage, such usage does not require precision. One can look vulnerable, feel vulnerable, or act vulnerable, and no one is likely to question the underlying assumptions or demand clarification. However, as soon as these words are transferred to a scientific context, other demands are put on them: when one scientist discusses "vulnerability to climate change," it is imperative that other scientists know precisely what is being discussed. Yet because these words are familiar, each of these scientists may well think they know what the other is talking about, when in fact they may be operating under different, and often unspecified, assumptions and with different conceptualizations.

The more traditional interpretation of vulnerability in climate change research is based on what Kelly and Adger (2000, p. 326) refer to as the "end point" of the analysis, whereby "assessment of vulnerability is the end point of a sequence of analyses beginning with projections of future emission trends, moving on to the development of climate scenarios, thence to biophysical impact studies and the identification of adaptive options". Any residual consequences that remain after adaptation has taken place define the levels of vulnerability. Vulnerability here summarizes the net impact of the climate problem, and can be represented quantitatively as a monetary cost or as a change in yield or flow, human mortality, ecosystem damage or qualitatively as a description of relative or comparative change.

The second interpretation considers vulnerability as a starting point for analysis. Rather than being defined by future climate change scenarios and anticipated adaptations, vulnerability represents a present inability to cope with external pressures or changes, in this case changing climate conditions. Here, vulnerability is considered a characteristic of social and ecological systems that is generated by multiple factors and processes. A focus on prior damage, referred to by Kelly and Adger (2000) as the "wounded soldier" approach, assumes that addressing present-day vulnerability will reduce vulnerability under future climate conditions (Burton et al., 2002). One purpose of vulnerability assessments using this interpretation is to identify policies or measures that reduce vulnerability, increase adaptive capacity, or illuminate adaptation options and constraints. This is achieved first and foremost by understanding the distribution and causes of vulnerability. For example, vulnerability mapping can be used to identify "hot spots" of vulnerability to climate change and other stressors, while case studies then provide an understanding of the underlying causes and structures that shape vulnerability (O'Brien et al., 2004). Understanding the biophysical,

[1] We recognize that vulnerability does not translate well into many languages, which adds further confusion to international debates about vulnerability to climate change.

social, political and cultural factors that contribute to climate vulnerability is seen as a critical prerequisite for taking actions to reduce this vulnerability.

The differences between these two interpretations can largely be explained by their contextual backgrounds and the research purposes from which they originated. The end-point approach to vulnerability originated with the goal of quantifying vulnerability to climate change, answering questions such as, "What is the extent of the climate change problem?" and "Do the costs of climate change exceed the costs of greenhouse gas mitigation?" The focus has often been on biophysical vulnerability, whereby the most vulnerable are considered to be those living in the most precarious physical environments, or in environments that will undergo the most dramatic physical changes (Liverman, 2001). Recognizing that impacts cannot be well quantified based on biophysical factors alone, social and economic factors have increasingly been included, or at least are recognized as a next step in the development of integrated assessment models (Tol and Fankhauser, 1998). Quantifying social vulnerability poses greater difficulty, yet remains an objective in climate impacts research (Luers et al., 2003).

The starting-point interpretation, on the other hand, has origins in assessments of social vulnerability with the purpose of identifying the character, distribution and causes of vulnerability. Research questions include, "Who is vulnerable to climate change and why?" and "How can vulnerability be reduced?" Many vulnerability studies draw on the entitlements literature regarding access to resources, on political economy in explaining the factors that lead to vulnerability, and on social capital as a means of claiming entitlements and pursuing coping mechanisms (Sen, 1981; Downing et al., 1995; Kelly and Adger, 2000; Adger, 2003). Vulnerability studies also focus on local livelihood strategies and the ways in which people secure these in dynamic physical and socio-economic environments (Scoones et al., 1996; Christoplos et al., 2001, Eriksen and Næss, 2003; Eakin, 2003). Yet it has also been recognized that biophysical conditions influence vulnerability, and that both environmental changes and social changes are linked through coupled human-ecological systems (Turner et al., 2003).

Critical to the starting-point interpretation is an understanding that vulnerability is a dynamic entity, in a continuous state of flux as the biophysical and social processes that shape local conditions and ability to cope also change (Handmer et al. 1999; Leichenko and O'Brien, 2002; Eriksen et al., submitted). This is in stark contrast with vulnerability as an end point, which often relies on static quantifications of vulnerability reflecting the net difference of impacts and adaptation. However, the most important difference between the two definitions is how they stand in relation to adaptation. As we will discuss below, viewing vulnerability as an end point assumes that adaptations and adaptive capacity determine vulnerability, whereas viewing vulnerability as a starting point says that vulnerability determines adaptive capacity and hence adaptations. Thus the entire causal direction is reversed, with serious implications for how both the problems and the solutions are viewed.

3 Adaptive capacity and vulnerability: which comes first?

Like vulnerability, adaptive capacity is a concept that has come to have multiple interpretations and nuances in the climate change literature. In general terms, adaptive capacity is defined in the climate change literature as "the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change" (Smit and Pilifosova, 2001, p. 881). The determinants of adaptive capacity include the range of available technological options for adaptation; the availability of resources and their distribution across the population; the structure of critical institutions and decision-making; human capital, including education and personal security; social capital, including property rights; the system's access to risk spreading processes; the ability of decision-makers to manage information; and the public's perceived attribution of the source of stress (Yohe and Tol, 2002). Yet this general definition again masks two interpretations that are closely linked to the end point and starting point interpretations of vulnerability.

In the end-point interpretation, adaptive capacity has been used as a measure of whether technological climate change adaptations can be successfully adopted or implemented. In the starting-point interpretation, adaptive capacity refers to the present ability to cope with and respond to stressors and secure livelihoods. Adaptive capacity in the first case refers to future adaptations and vulnerability (Brooks, 2003), while adaptive capacity in the second case pertains to present-day vulnerability (Burton et al., 2002).

These different understandings of adaptive capacity are directly related to understandings of adaptation, which can be generally defined as an "adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts" (Smit and Pilifosova, 2001, p. 881). Burton et al. (2002), however, point out that even the term adaptation has multiple interpretations, roughly representative of "first generation" and "second generation" adaptation research. The first generation of adaptation research is impacts-driven, employing the standard seven-step approach outlined in IPCC Guidelines (Carter et al. 1994) and oriented towards mitigation policies. "What matters in this connection is the extent to which the gross impact of climate change can be reduced by adaptation" (Burton et al., 2002, p. 147). Scenarios are imposed on biophysical and socio-economic systems, usually through the use of models, to determine potential impacts in various natural, economic and social sectors (exemplified in Yohe and Schlesinger, 2002; Sutherland and Gouldby, 2003). This approach relies on future scenarios and directs attention towards future impacts of climate change rather than towards present vulnerability. Present and future socio-economic conditions are given little consideration, except as part of global scenarios needed to project emissions and calculate impacts, based on the IPCC's SRES scenarios (see Arnell et al., 2004). However, due to uncertainties in the climate scenarios, climatic effects on sectors, and future socio-economic conditions, it becomes practically impossible to formulate specific climate change adaptation policies.

The second generation of adaptation research, in contrast, considers adaptations in response to a wide variety of economic, social, political and environmental circumstances. The point of departure is the present, in terms of the distribution of vulnerability, existing adaptations to the climatic environment, and the way that current policies and development practice serve to reduce or exacerbate vulnerability. Future climatic and socio-economic conditions are taken into account in assessing and prioritizing policy options, but only to set the context for future adaptations. Rather than comprising a separate climate policy, the identified adaptation options should ideally be incorporated into a wide range of policies; for example, agricultural, water resources, public health and development policies (Burton et al., 2002).

Confusion often arises because many of the underlying drivers of vulnerability, such as poverty and economic marginalization, often coincide with the determinants of adaptive capacity. Considering adaptive capacity as the inverse of vulnerability (see, for example Yohe and Tol, 2002) may thus not only ignore the drivers of vulnerability, but also conceal differences in time scale and other assumptions underlying the two approaches. In the next section, we consider some of the consequences of the different interpretations and approaches to vulnerability and adaptation in climate change research.

4 Consequences: different diagnoses, different cures

Because the two interpretations differ so much in their content, origins, and assumptions about adaptation, they differ considerably in how they are used in practical research. They entail radically different "diagnoses" of a problem, and thus very different "cures." The end point approach originates from a perception that diagnoses climate change as the main problem; cures entail greenhouse gas emissions reductions and reduction of the sensitivity of various economic, social and environmental sectors and systems to projected changes in particular climate parameters. The starting point approach diagnoses inherent social and economic processes of marginalization and inequalities as the causes of climate vulnerability and seeks to identify ways of addressing these.

The end-point or "residuals" interpretation of vulnerability represents a strong "scientific" understanding of climate change and other environmental problems, where science is seen as playing a central role in both identifying and explaining (i.e., diagnosing) environmental problems, and providing a basis for defining solutions to them (i.e., recommending a cure). This central role of science has been increasingly used to justify managerial and technocratic interventions by governments (Berkhout et al., 2003).

For example, the U.S. Country Studies Program, the UNEP Country Studies, and other such climate change impact and adaptation assessments were carried out with the objective of identifying potential measures for adapting to climate change (O'Brien, 2000; Smith and Lazo, 2001). The seven steps of climate impact assessment described earlier were used in combination with an array of climate change scenarios, biophysical models, economic models, integrated systems models, empirical studies, and expert judgments to identify impacts and adaptation options. Identified adaptation options included irrigation, drainage systems, coastal setbacks, or relocation of settlements, which can be achieved through economic assistance and enhancement of institutional capacities. The approach to these country studies was largely biophysical, aimed at identifying vulnerability as an end point to the analysis, once adaptation was taken into consideration. What emerges is a list of activities that need to be funded: Irrigation schemes, drought-tolerant seed varieties, raised bridges, structural improvements in housing, and so forth.

However, an assumed knowledge of future climate is deeply embedded in the end-point analyses, both in terms of impacts and adaptations. If or when climate change manifests itself differently than expected over the short or long term (e.g., floods rather than drought), predefined technological adaptations may become inappropriate. If climate change is characterized by increasing climate variability and extreme events (see, for example, Easterling et al., 2000; Schär et al., 2004), then it is likely that some adaptations may, at some point in time, be considered maladaptations (Schneider et al., 2000; Burton et al., 2002; Klein, 2003; Adger, 2003b). Pittock (2000, p. 403) points out that "increasing reliance on limited technological fixes such as levees, sea walls, and new monoculture crop cultivars" may make society more vulnerable in the long run because they may lead to increased investments and population concentration in locations subject to climate hazards.

When vulnerability is viewed as a starting point, however, vulnerability assessments can be used to identify adaptive capacity, which in turn provides insights to the opportunities and constraints to implementing specific adaptation policies (Burton et al., 2002). In contrast to the "first generation" adaptation studies described earlier, the type of policy measures that emerge are social rather than technical in nature, and include poverty reduction, diversification of livelihoods, protection of common property resources, and strengthening of collective action (Kelly and Adger, 2000). Such measures strengthen the ability to respond to stressors and secure livelihoods under present conditions, which should then increase the capacity to adapt to changing conditions in the future. This approach allows for adaptation to uncertainty, which has been increasingly identified as a distinguishing characteristic of environmental change and policy (Mitchell and Hulme, 1999; Lempert et al., 2000; Berkhout et al., 2003). This type of research is exemplified in studies by Adger et al. (2001) and Eakin (2003)

Furthermore, a closer reading of climate change country studies also suggests that vulnerability is not simply the residual of impacts and adaptations, but a general characteristic generated by ongoing social and environmental problems that can be reduced by addressing current problems, irrespective of the exact direction or magnitude of future climate change (O'Brien, 2000; Smith and Lazo, 2001). Most of the UNEP country studies on impacts and adaptation to climate change concluded that addressing contemporary socioeconomic and environmental challenges were critical to confronting future climate change (O'Brien, 2000). Adaptation measures based on technological or engineering solutions were seldom identified as priorities over management improvements, such as increasing institutional capacity to administer and regulate environmental issues, or a greater commitment of resources to support existing regulations or policies.

Finally, when vulnerability is discussed, it is usually in reference to damage or negative effects. Yet what constitutes "damage" or "negative effects" varies across contexts and cultures. Most vulnerability studies that have been carried out in developed countries have reflected an emphasis on the performance of economic sectors, such as agriculture, or physical infrastructure (Abler, 2000; Graves, 2000; Parry, 2000). It is the more subtle impacts that may have greater relevance to individuals and communities (for example, related to skiing in Norway or gardening in England), and these are often disregarded as trivial based on economic measures.

In developing countries, vulnerability studies generally focus on a household's ability to sustain adequate nutrition and avoid death (McCarthy et al., 2001; FEWS-NET, 2004). While important, this too represents an overly simplistic view of what constitutes well-being among poor populations because objectives and values differ between and within households (Davies, 1993). For example, maintaining respect from other villagers through farming was an important factor in coping with drought in Mozambique (Eriksen and Silva, 2003).

In short, the values deemed important to a society or community may include more than life and property. A sociological definition of well-being in Norway is linked to factors beyond material welfare and health, such as family, neighborhood, and profession (Næss, 2001). Although the sociological definition treats well-being as pertaining to individuals rather than societies, these insights direct our attention towards the possibility of what Farley and Costanza (2002) term "desirable ends for society." In general, climate vulnerability studies have ignored local perceptions and contexts that define "quality of life" and well being in both developed and developing countries. As we will illustrate below, well-being may involve more than food security or economic performance, and include such aspects as a feeling of security, sense of belonging, respect, social and cultural heritage, equality and distribution of wealth, dispersed settlement, access to nature-based outdoor activities and control over one's own destiny.

5 Illustrations: The cases of Norway and Mozambique

The above sections have argued that the two interpretations of vulnerability have implications for both the diagnosis of vulnerability and its cure. This section demonstrates these implications by showing how the different types of analysis apply to the case of Norway and Mozambique—two countries characterized by very different economic, social, and environmental conditions.[2] Exposure and sensitivity to climate change can be considered high in both countries, as we will discuss below. Vulnerability, however, is generally considered much higher in Mozambique than in Norway. Norway has a high per capita income, egalitarian income distribution, high technological development, and high levels of education, and there is an assumption that Norway can quite easily adapt to climate change (O'Brien et al., 2004). In contrast, Mozambique, with a low per capita income, low levels of technological development, and low adult literacy, is considered highly vulnerable because it has a low adaptive capacity relative to the expected changes in climate (see Table 1). Yet this type of end-point perspective of vulnerability, where adaptability defines vulnerability, can be misleading. Below, we contrast the two approaches and emphasize important facets of vulnerability that are obscured or omitted with an end-point interpretation, yet which represent real concerns to the people living within both countries.

Table 1: Indicators of adaptive capacity

Determinants	Indicators	Norway	Mozambique
Economic wealth	GDP/capita	36815	200
Technology	Personal computers in use per 100 people	50.8	0.4
Information and skills	Adult literacy rate	99.0	45.2
Infrastructure	Population without sustainable access to an improved water source	0	43
Equity	Gini coefficient	25.8	39.6

Source: UNDP, 2003

5.1 Mozambique

End point analyses indicate that Mozambique is highly vulnerable to climate change. That is, the net impacts of climate change are likely to be very high. Global climate change is projected to bring a number of changes to local climate conditions. Rainfall in southern Africa is presently characterized by high variability both seasonally and annually (Hulme et al., 2001). The character of atmospheric circulation over eastern and southern Africa means that the regional climate is highly sensitive to small changes in the global climate (Tyson et al., 2002). Future warming is likely to be greatest over the interior of the semi-arid margins of the Sahara and central southern Africa (McCarthy et al., 2001). In addition, rainfall is likely to decrease in many areas, although there are great uncertainties attached to model simulations of future climate. However, surface runoff, which is a product both of rainfall and increased evaporation due to higher temperatures, is likely to decrease over most of southern and eastern Africa (PRECIS, 2001). Climate scenarios interpreted specifically for Mozambique suggest that a doubling of CO_2 in the atmosphere could lead to an increase in the mean annual temperature by 1.8–3.1^{o}C, a 2–9% decrease in rainfall, and a 2–3% increase in solar radiation by 2075 (MICOA, 2000). Evidence suggests that the variability and intensity of extreme events in southern Africa may already be increasing (Tyson et al., 2002) and that the frequency and intensity of floods and droughts can be expected to rise (Joubert and Hewitson, 1997).

[2] According to the UNDP Index of Human Development (2002), the two countries can be considered extremes: Norway ranks first and Mozambique occupies the 170th spot out of 175 countries included in the analysis.

A draft national vulnerability assessment for Mozambique by the Ministry Coordination of Environmental Affairs (MICOA, 2000) points out that future climate change and increased variability are likely to adversely affect a number of sectors. Reduced runoff, for example, could exacerbate current water stress, reduce the quality and quantity of water available for domestic and industrial use, and limit hydropower production. Any increase in the intensity or frequency of cyclones and high intensity rainfall would increase the threat of floods. Sea level rise also represents a threat through saltwater intrusion and coastal erosion, particularly around the larger rivers (MICOA, 2000). The agricultural sector and rural populations are likely to be most vulnerable. A detailed analysis carried out in Chokwe District, a rainfed agricultural area in a relatively dry part of southern Mozambique indicated a reduction in maize yield by 5–70% by 2075 under CO_2 doubling (MICOA, 2000). Recent floods and droughts appear to confirm the likely vulnerability of Mozambique to climate change: during the 2000 floods, 700 people died, 550,000 had to be relocated from their homes, and 200,000 lost their farmland (Christie and Hanlon, 2001). A drought that began in 2001 and culminated in 2003 put 659,000 people in need of food aid (FEWS-NET, 2004).

The draft vulnerability report for Mozambique identifies a number of adaptation options. Coastal erosion and salt water intrusion can be addressed through a combination of integrated and participatory management, construction of dikes and seawalls, and use of natural means of coastal dune building. Decreased freshwater availability can be addressed by increased efficiency of water use, construction and improvement of dams, irrigation channels and establishment of schemes for recycling of water. The impacts of climate change on the agricultural sector can be addressed with adjustments such as changes in crop types, season and location of farming, or development of intensified and mechanized farming, with intensive use of fertilizers and irrigation. However, as depicted in Table 1, the ability of Mozambique to implement many of these measures may be low, since Mozambique generally lacks the technological, institutional and infrastructural capacity to successfully undertake adaptation measures.

More fundamental questions arise when vulnerability in Mozambique is taken as the starting point of the assessment. A starting-point analysis shows that maladjusted practices and technologies are just a symptom of vulnerability. The fundamental causes of vulnerability, including marginalization and inequity, may have to be addressed in order to achieve effective adaptation. Local level analysis carried out by Eriksen and Silva (2003) shows large variations in vulnerability both within and between communities in Mozambique. The effects of the 2000 floods and the 2001-2003 drought were investigated in two villages: Massavasse located in the Chokwe District; and Matidze located in the neighboring Mabalane District. The analysis illustrates some of the multiple factors that influence the distribution of vulnerability.

First, dryland rain-fed farming, predominant in Matidze, appears to be undergoing a process of marginalization. For example, irrigation based villages in Chokwe District were the target of government, international aid agency and NGO assistance both in reconstruction and recovery after the floods and in infrastructural and agricultural development. In contrast, most villages in Mabalane District received no such attention, thus agricultural tools and equipment lost during the 2000 floods were not replaced, affecting consecutive harvests. In particular, the small-scale irrigation that would have provided food and income during the drought had all but disappeared.

Second, the opening up of market opportunities with increased trade and liberalization of the economy was having very unequal benefits. Income opportunities in trade of agricultural goods as well as forest products, particularly charcoal, and casual employment on commercial farms provided new sources of livelihoods for many. Market based mechanisms were more robust in the face of drought in Massavasse, where access to regional and national markets was fairly good. In Matidze, most of the market-based coping strategies proved unviable or yielded very marginal profits as the drought intensified. While some commercial farmers in Massavasse, with access to water through pump irrigation, market information, and transport, were able to continue production of vegetables and benefit from elevated prices in markets in nearby towns and in Maputo, small-scale farmers in Matidze saw their livelihood options dwindle, and were pushed into activities in which an increasing number of villagers were already engaging and which yielded marginal income, such as production of sweet potato and pumpkin leaves in the river bed, and charcoal production.

Third, poor health services magnified the effect of the spread of HIV/AIDS (affecting an estimated 23% of the population, Chokwe Catholic Hospital Estimate November 2002), which then affected the health and labor power of household members, reducing household ability to secure livelihoods. Another example of a process affecting an important source of household income was the increasing restrictions on migration to South Africa, partly due to the rising unemployment in South Africa and reduced need for immigrant labor.

The most vulnerable in Mozambique are thus unlikely to be reached by technical interventions. The implementation of such measures as part of agricultural development efforts has led to an expansion of agricultural extension in irrigated areas and the areas of greatest agricultural production potential, with technical improvement mainly targeted at irrigation farmers. In effect, the technological expertise is of most use to the more wealthy farmers who can afford to invest in the new technology, while fewer technical options are available for rain-fed farming, or the plethora of other livelihood activities in which people engage (Eriksen and Silva, 2003). Technological measures may actually be counterproductive and exacerbate inequality and processes of marginalization of rural households that are currently contributing to vulnerability, instead of effectively reducing vulnerability (Adger et al., 2003).

Taking vulnerability as a starting point for analysis focuses attention on people's strategies to secure livelihoods and the processes that constrain and enhance the options available to them. Such analysis leads to very different types of measures, such as those aimed at enhancing the position of dryland agricultural and forest products in market transactions and retargeting of government and aid investment in order to address any skewed distribution. Measures such as the development of local niche products, or the strengthening of local knowledge, market information and access to markets, are much more inter-sectoral than those suggested by end-point analysis. Measures aimed at supporting the diversification of local livelihoods and well-being in the present are also likely to be more relevant to the context of contemporary concerns than measures aimed at reducing sensitivity to very specific future climate impacts, the particular character of which at local level are not well known.

5.2 Norway

With climate change, Norway is expected to experience a warming of 0.1 to 0.5º C per decade from 1990 to 2050 (Benestad, 2002). Temperature increases are likely to be the highest in the north and in inland areas. Precipitation may increase by an average of 10%, with most of this occurring in the southwestern region, and along the western coast further to the north. Modeling results from the RegClim project indicate a tendency towards more extreme events, including heavy precipitation and strong winds (RegClim 2003; O'Brien et al., 2004b). This could lead to increased winter flooding in the southern parts of the country.

While no comprehensive climate change vulnerability assessment has been carried to date in Norway, a national climate impacts study from 1991 assessed impacts on ecological systems, agriculture, arctic areas, coastal areas, harbor and coastal installations, fisheries, water resources, health, and recreation and tourism (Miljøverndepartementet, 1991). This sector-based study indicated that Norway may have to adapt to both positive and negative effects of climate change. For example, increased CO_2 concentrations and higher temperatures could potentially lead to increased productivity in the agricultural sector, increased potential for cultivating new species, and potential increase in arable land (NILF, 1990; Miljøverndepartementet, 1991). The growing season may increase by 20–30 days in many parts of the country by the year 2050 (Skaugen and Tveito, 2001). To realize the benefits of a longer growing season, adaptation would entail switching to new plant species for cultivation and expanding the areas of cultivated land. At the same time, however, warmer weather may lead to an increase in erosion and nutrient loss, as well as an increase in the incidence of pests and diseases, poor snow cover, and hoar frost, posing threats to forest and agricultural yields as well as to natural ecosystems (O'Brien et al., 2004b). Such changes would imply a need for increased use of pesticides, as well as measures to combat erosion.

If vulnerability is interpreted as an end point, Table 1 indicates that Norway perhaps need not worry too much; the country scores well on indicators related to high adaptive capacity and should thus have a low vulnerability. When studying vulnerability from a starting point approach, however, two concerns disturb this picture. First, Norway's high national adaptive capacity masks great internal variations in vulnerability. O'Brien et al. (2004b) showed how vulnerability for Norway varies according to the geographic scale at which it is studied, with some regions and populations emerging as vulnerable through regional or local-level assessments because of a high reliance on climate-sensitive economic activities and low adaptive capacity. A mapping of adaptive capacity shows that some municipalities—particularly rural municipalities in mid-Norway—have a relatively lower capacity to adapt to positive or negative climate changes (O'Brien et al., 2003). Low adaptive capacity is related to rural-urban migration, an aging population, a declining tax base, and weak economic prognoses.

Second, adaptation does not appear to be taking place automatically in Norway. Despite a high adaptive capacity on paper, recent studies imply several constraints to adaptation. For example, although the knowledge, technological capacity, expertise, and regulations exist, they are not always put to use. For instance, it was found that most of the damages associated with a 1992 storm could have been avoided had building regulations actually been followed in the construction of new houses (Lisø et al., 2003). Similarly, a study of responses by municipal administrations to the 1995 floods indicated that adaptation measures and learning from the experience were incomplete (Næss et al., 2004). The data suggest that information flows between government and planning institutions at municipal, regional and national levels are not always well-functioning. Local contextualized knowledge, as well as information gleaned from the flood incident regarding climatic-related events and how a community can best respond to a flood or plan to avert flood risk often remains personalized and not well integrated in formal procedures and planning. In addition, economic pressures may influence municipal planning decisions and lead to increased vulnerability, such as through the building of residential housing or economic installations in flood-prone areas (Næss et al., 2004).

Significantly, while few Norwegians are threatened by starvation or death due to climate change impacts, other aspects of Norwegian life are vulnerable to climatic variability and change. Potential adverse effects to a community or an individual are often perceived in a wider sense than that implied by measures of loss of lives, damage to buildings and infrastructure, or economic performance of a sector. In addition to physical safety, a psychological sense of security, and cultural heritage, values such as love, good health, nature and a meaningful job are important (Hareide, 1991; Håland, 1995). In a recent pilot study on vulnerability among farmers in climatologically marginal areas, qualitative interviews with eight farmers and key informants were carried out in Øystre Slidre, a mountain community in southern Norway. This study, as well as recent focus group interviews with Norwegian municipal administrations and politicians (Eriksen, 2003), suggests that there are a number of values that are not necessarily economic in nature that form part of the local perception of well-being and which may be vulnerable to the combined effect of climatic and economic changes. For example, any declines in rural populations would lead to a loss of local community and sense of belonging that would constitute a major adverse effect for those living there.

In the Norwegian mountain farming case, local knowledge about the environment and weather patterns, social networks, and diversification into non-farming sectors emerged as critical to the ability of farmers to sustain their livelihoods in the area. A number of processes are perceived as threatening these strategies. Poor agricultural prices are discouraging younger people from taking over the farm when their parents become old, smaller farms are being merged, and local knowledge is being lost as the 'older' generations gradually disappear out of the sector. Growing employment in the service sector is enabling people to stay in the community; however, in many other rural communities in Norway, the worsening of municipal economies combined with devolution of responsibilities from the national to the municipal administrations may contribute to a decline in the quality of social services and welfare. Furthermore, changes in agricultural policies and government transfers, and in particular those that support rural populations and economic activities, would completely alter the local economy and people's ability to make a living.

The vulnerability effects of social change and larger scale economic and political changes, such as membership in the European Union, remain largely understudied. Similarly, whether or not the optimal adaptations of the crop calendar or crop types required to realize the increased agricultural potential are possible in the context of structural changes in Norway's agricultural sector is not well known (O'Brien et al., 2004b). The question of vulnerability and adaptation is, therefore, an intersectoral one. Vulnerability in Norway must investigated as a starting point for identifying whether and how adaptation to climate change can take place.

6 Conclusion

Research on vulnerability is ideally a multidisciplinary endeavor involving physical and social scientists with diverse specializations. Yet, to identify and elaborate on vulnerability, a common understanding of the concept is essential. In this paper, we have pointed to the scholarly confusion and policy implications created by conflating two very different research questions – those of "What are the net impacts of climate change?" and "Why are some groups likely to be more adversely affected than others?" – within the single concept of vulnerability. The first research question is driven by the issue of determining whether the benefits of mitigation exceed the costs of greenhouse gas reductions, and the second is driven by the underlying purpose of identifying how vulnerability can be reduced. We have argued that because the two different interpretations of vulnerability have two different conceptions of the problem, they will necessarily have two different approaches to the solution.

From a policy perspective, the distinction is significant. Decision-makers faced with the issue of climate change must decide whether and how to mitigate climate change through decreased emissions of greenhouse gases, and how to adapt to the changes that are likely to result, regardless of the emissions reductions pursued in this century. This raises questions of what, how, and who to fund in terms of climate change adaptations (Huq and Burton, 2003).

The interpretation of vulnerability then comes to be of paramount importance. If vulnerability is the end point of the analysis, then it can be addressed by limiting impacts (by reducing exposure through mitigation of greenhouse gas emissions), or by increasing adaptations that reduce climate sensitivity (e.g., drought-tolerant seed varieties, infrastructure changes). Increasing adaptations can be facilitated by increasing "adaptive capacity" to climate change, in order to promote the uptake of technological adaptations. Although general development would facilitate such technological uptake, the end-point interpretation focuses on technology and transfer of technology, rather than on development. Finding ways to promote technical adaptations to climate change in the most vulnerable countries has become a key issue in climate change negotiations, with much of the attention focused on sources of funding, as well as the emerging issues of equity and compensation (Müller, 2002; Paavola and Adger, 2002).

When vulnerability is taken as the starting point of the analysis, the focus of the assessment is quite different. Vulnerability to climate change is recognized as a state, generated not just by climate change, but by multiple processes and stressors. Consequently, there are multiple points for intervention. Technological adaptations to climate change represent only one of many options – albeit a problematized one due to existing social, economic and political structures that may increase inequality in a community and exacerbate vulnerability for some. Addressing climate change means enhancing the ability to cope with present-day climate variability and long-term climate uncertainty. To do this, there is a need to first understand the drivers that underlie vulnerability. Thus although some of the same determinants of adaptive capacity are involved, the focus of any intervention is not only to promote technological adaptations, but also to improve coping capacity and decrease vulnerability to climate change and other stressors.

This interpretation makes vulnerability as relevant to Norway as to Mozambique. It acknowledges that within any region, sector, or social group, there are likely to be some that are more vulnerable to climate change for a variety of reasons, including exposure to other stressors, such as economic liberalization and structural adjustment programs, devolution of responsibilities from state to local authorities, HIV/AIDS, and violent conflicts. It acknowledges that climate change itself will have differing degrees of importance, depending on how it is manifested in a particular area. Through the lens of vulnerability, in areas that face multiple stressors, climate change may be the stressor that pushes people or ecosystems "over the edge."

There is little doubt that technological adaptations such as irrigation schemes, drought-tolerant seed varieties, raised bridges, structural improvements in housing and so forth can decrease vulnerability to climate change in many countries. Yet reducing climate change vulnerability to the mathematical or theoretical difference between impacts and adaptations underestimates the breadth and depth of consequences that climate will have on both environment and society. Ironically, by making the net impacts of climate change the focus of vulnerability analyses, climate change becomes a small problem. If the underlying causes and contexts of vulnerability are not taken into account, there is a danger of underestimating the magnitude, scope (social and environmental) and urgency of climate change.

Looking at vulnerability as an end point has played a useful role in measuring the extent of the climate change problem, and weighing the costs of impacts and adaptations against the costs of greenhouse gas mitigation. However, continuing to view vulnerability as an end point by focusing on adaptive capacity and ability to implement technical solutions can lead to the danger that adaptation is reduced to building local capacity rather than addressing the fundamental causes of vulnerability, including the geopolitical and economic contexts (Brooks, 2003). Future climate change scenarios and estimates of impacts can provide a useful contextual frame for studies that take climate change as a starting point. However, to understand vulnerability, as well as adaptation, "greater insights can be gained from looking around and looking back than from looking forward" (Adger 2003b, p. 30).

One way of resolving the prevailing confusion is to make the differing interpretations of vulnerability more explicit in future assessments, including the IPCC Fourth Assessment Report. To make the distinction more clear, the term 'net impacts' could be adopted to describe the residual between climate impacts and adaptive capacity, while climate vulnerability (as opposed to climate change vulnerability) could be used to describe a convergence of multiple processes and outcomes manifested as the inability to cope with or adapt to climate variability and change. If we continue to conflate the two interpretations of vulnerability, however, and ignore their ramifications, there is a risk of not only continued scholarly misunderstanding, but also of treating the symptoms of vulnerability instead of its causes.

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