



## Surveys

## Combining analytical frameworks to assess livelihood vulnerability to climate change and analyse adaptation options



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## ABSTRACT

Experts working on behalf of international development organisations need better tools to assist land managers in developing countries maintain their livelihoods, as climate change puts pressure on the ecosystem services that they depend upon. However, current understanding of livelihood vulnerability to climate change is based on a fractured and disparate set of theories and methods. This review therefore combines theoretical insights from sustainable livelihoods analysis with other analytical frameworks (including the ecosystem services framework, diffusion theory, social learning, adaptive management and transitions management) to assess the vulnerability of rural livelihoods to climate change. This integrated analytical framework helps diagnose vulnerability to climate change, whilst identifying and comparing adaptation options that could reduce vulnerability, following four broad steps: i) determine likely level of exposure to climate change, and how climate change might interact with existing stresses and other future drivers of change; ii) determine the sensitivity of stocks of capital assets and flows of ecosystem services to climate change; iii) identify factors influencing decisions to develop and/or adopt different adaptation strategies, based on innovation or the use/substitution of existing assets; and iv) identify and evaluate potential trade-offs between adaptation options. The paper concludes by identifying interdisciplinary research needs for assessing the vulnerability of livelihoods to climate change.

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## 1. Introduction

The impacts of future climate change on many ecosystem services<sup>1</sup> are uncertain, but it is clear that those who depend most on natural resources are likely to be most severely affected (e.g., African Development Bank et al., 2003; Burton et al., 2002; Simms et al., 2004). Although the challenges of climate change may seem distant and marginal compared to poverty

alleviation and economic development in the developing world, there is a growing recognition that poverty and the impacts of climate change are closely interconnected, e.g., impacting upon land availability (due to sea-level rise), water availability for rain-fed agriculture and reducing production in fisheries due to the emergence of new diseases and other factors (Schipper and Lisa, 2007). It is also recognised that both these issues are inextricably linked to land degradation and sustainable land management (UNCCD, 1994). Unless we can better understand what the future might hold and how to prepare for it, we could see major disruptions to ecosystem services that could threaten existing livelihoods and further increase the vulnerability of the poor to climatic and other future changes, e.g., related to globalisation (Davidson et al., 2003; O'Brien et al., 2007). This presents a challenge for experts working on behalf of international development organisations, who need better tools to assist land managers in developing countries maintain their livelihoods, as

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<sup>1</sup> Defined as “the benefits people obtain from ecosystems” (Millennium Ecosystem Assessment, 2003: 38).

climate change puts pressure on the ecosystem services that they depend upon. However, existing analytical frameworks struggle to deal with the complex interactions between climate change and other existing or future stresses, or to explain how vulnerability may be mediated by new adaptations to climate change. Theory is also split over how these adaptations are likely to emerge and how they are likely to be adopted by the sorts of communities in the developing world that often make their livelihoods from a highly dynamic and heterogeneous resource-base.

Although the sustainable livelihoods framework (Carney, 1998; Scoones, 1998) offers many useful insights, it also has a number of limitations (e.g., Small, 2007), and has rarely been used to assess the vulnerability of rural livelihoods to climate change. This paper therefore explores synergies between this and other widely used analytical frameworks, with the goal of developing an integrated framework for assessing livelihood vulnerability to climate change. To do this, we first describe and compare a number of relevant analytical frameworks. Next, we draw these together into a novel integrated analytical framework. We then use this framework to identify research needs and relevant methods by development practitioners and others to operationalise the framework. The paper draws on case study research from southern Africa, where the challenge of tackling climate change in combination with poverty, land degradation and loss of biodiversity, is particularly acute.

## 2. Analytical Frameworks to Understand Livelihood Vulnerability to Climate Change

There are many different interpretations of the concept of vulnerability in relation to climate and other environmental changes (e.g., Adger, 2006; Bohle et al., 1994; Downing et al., 2005; Holling, 1986; IPCC, 2001a, 2001b; Kasperson et al., 1995; Kelly and Adger, 2000; Smit and Wandel, 2006; Wisner et al., 2004). Whilst there is little consensus about its precise meaning (Gallopín, 2006), the concept usually relates to the degree to which a human social and/or ecological system will be affected by some form of hazard (Turner et al., 2003). Hazards can take the form of perturbations, which are major spikes in some kind of pressure (e.g., hurricane and sudden global economic crisis), or stresses, which are continuous slowly increasing pressures (such as soil degradation). In addition, some spikes may have a cumulative effect, especially when added to underlying pressures. Hazards can arise from both within and outside the system of study (Kasperson et al., 2005; Turner et al., 2003). Vulnerability also does not always have negative connotations, and can be expressed as a positive, such as the degree to which a social group can emerge from poverty (Gallopín, 2006).

Despite numerous interpretations, the literature consistently considers vulnerability of any system to be a function of three elements: exposure to a hazard; sensitivity to that hazard, and the capacity of the system to cope, adapt or recover from the effects of those conditions (Smit and Wandel, 2006). Exposure is the degree, duration, and/or extent in which the system is in contact with, or subject to, the disturbance (Kasperson et al., 2005); sensitivity is the degree to which a system is modified or affected by a disturbance (Gallopín, 2006); and the capacity to respond (also known as adaptive capacity) is the ability of a system to cope or recover from the disturbance (Smit and Wandel, 2006). Gallopín (2006) gives an example of the effects of flooding on a community where the most precarious homes are hit harder by a flood than the more solid ones (sensitivity); the poorest households are often located in the places most susceptible to flooding (exposure); and families with greater resources are in better position to repair water damage or move elsewhere (adaptive capacity). The combination of the three elements therefore determine the degree to which a household, community, or system is vulnerable to changing climatic conditions. These elements are usually incorporated into vulnerability assessments in one way or another (e.g., IPCC, 2001a, 2001b; Metzger and Schroter, 2006).

There are many approaches to assessing vulnerability to climate change (e.g., Fussler and Klein, 2006; IPCC, 2001a, 2001b; Metzger and

Schroter, 2006). Fussler and Klein (2006) suggest four stages assessing vulnerability to generate more effective adaptation policies: initial impact assessment (evaluation of the potential effects of climate change scenarios which affect the degree of exposure of the system being assessed); first and second generation vulnerability assessments (evaluation of climate impacts in terms of their relevance for society and consideration of potential and feasible adaptive capacity); and adaptation policy assessments (evaluations to provide specific recommendations to planners and policy-makers). At the scale of local communities, vulnerability assessments typically involve ethnographic methods to identify and document the conditions or risks people have to deal with, cataloguing how they have adapted to previous perturbations. This may then be combined with information from other researchers and policy analysts to help identify future exposures and sensitivities and the ways that it may be possible to help communities plan for or respond to these conditions (Smit and Wandel, 2006).

Vulnerability assessments do often take into account livelihoods and/or the factors that are likely to constrain or influence the way in which adaptation may occur. However, as yet there has been no framework proposed to specifically analyse the vulnerability of livelihoods to climate change per se, or that integrates different analytical frameworks to help understand different aspects of vulnerability to climate and other types of changes and the interactions between these drivers of change. To do this, the rest of this paper therefore integrates a number of commonly used analytical frameworks that have not previously been brought together: sustainable livelihoods, ecosystem services, diffusion theory, social learning, adaptive management and transitions management. Each of the frameworks contribute in different ways to a more holistic and comprehensive approach to assessing and reducing the vulnerability of livelihoods to climate change. In the following sections, each framework is described and compared in turn, pairing frameworks that contain the most conceptual overlap, and moving from frameworks that consider vulnerability at micro-scales to meso- and macro-scales. The final part of this section then compares and integrates the insights that emerge from this analysis, as the basis for the integrated framework that is proposed in the following section of the paper.

### 2.1. Sustainable Livelihoods Framework and Ecosystem Services

The sustainable livelihoods framework is particularly relevant to understand vulnerability to climate change because it provides a framework for analysing both the key components that make up livelihoods and the contextual factors that influence them. Both of these relate closely to the elements that make a household or community more sensitive or exposed to the effects of a changing climate and affect their ability to cope with environmental change (Eakin and Luers, 2006). There is, for example, a growing appreciation of the links between climate change and poverty, which explores how livelihoods might be affected (Ziervogel et al., 2006). Climate change can disrupt established ecological and land use systems, which in turn can compromise food and water supplies, which in turn impact upon livelihoods. For example, changes in seasonality may determine whether wetlands become affected by salinisation, rendering the soil infertile (Jin, 2008). Through the impacts of climate change on ecosystem services, livelihood options can be reduced and poverty increased. This then has further impacts on the adaptive capacity of households when they are faced with other perturbations or stresses.

The sustainable livelihoods framework is based on understanding people's access to assets that typically include natural, human, social, physical and financial capital. Other assets are increasingly being used in such analyses, such as information, cultural/traditional and institutional assets (e.g., Cochrane, 2006; Otero, 2008). Access to these assets are then analysed in relation to the context of that livelihood (e.g., climate, demography, history and macro-economic conditions), institutional and social processes (e.g., organisational arrangements and land tenure), and the livelihood strategies that are used (combinations of

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