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Adaptation, adaptive capacity and vulnerability

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Abstract

This paper reviews the concept of adaptation of human communities to global changes, especially climate change, in the context of adaptive capacity and vulnerability. It focuses on scholarship that contributes to practical implementation of adaptations at the community scale. In numerous social science fields, adaptations are considered as responses to risks associated with the interaction of environmental hazards and human vulnerability or adaptive capacity. In the climate change field, adaptation analyses have been undertaken for several distinct purposes. Impact assessments assume adaptations to estimate damages to longer term climate scenarios with and without adjustments. Evaluations of specified adaptation options aim to identify preferred measures. Vulnerability indices seek to provide relative vulnerability scores for countries, regions or communities. The main purpose of participatory vulnerability assessments is to identify adaptation strategies that are feasible and practical in communities. The distinctive features of adaptation analyses with this purpose are outlined, and common elements of this approach are described. Practical adaptation initiatives tend to focus on risks that are already problematic, climate is considered together with other environmental and social stresses, and adaptations are mostly integrated or mainstreamed into other resource management, disaster preparedness and sustainable development programs.

Keywords: Adaptation; Adaptive capacity; Vulnerability; Applications; Community; Participatory; Bottom-up; Implementation; Mainstreaming

1. Introduction

This paper reviews the concept of adaptation in the context of adaptive capacity and vulnerability of human systems to global changes, especially climate change. A particular focus is on recent developments in scholarship that contribute to practical applications of adaptation and adaptive strategies. Kelly and Adger (2000), Füssel (2004) and O'Brien et al. (2004a) distinguish applications of research relating to vulnerability, including studies that relate to adaptation. The applications of interest here are those that contribute directly to adaptation initiatives to tangibly influence the vulnerability of human communities or societies to conditions related to climate change.

Adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity. Numerous definitions of adaptation are found in climate change literature, mostly variations on a common theme. Brooks (2003, p. 8), describes adaptation as "adjustments in a system's behavior and characteristics that enhance its ability to cope with external stress". Smit et al. (2000, p. 225), in the climate change context, refer to adaptations as "adjustments in ecological-socio-economic systems in response to actual or expected climatic stimuli, their effects or impacts." Pielke (1998, p. 159), also in the climate context, defines adaptations as the "adjustments in individual groups and institutional behavior in order to reduce society's vulnerability to climate." Based on their timing, adaptations can be anticipatory or reactive, and depending on their degree of spontaneity they can be autonomous or planned (Fankhauser et al., 1999; Smit et al., 2000).

The concepts of *adaptation*, *adaptive capacity*, *vulnerability*, *resilience*, *exposure* and *sensitivity* are interrelated and have wide application to global change science. Analyses range in scale from the vulnerability and

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adaptation of an individual or household to a particular climate stress such as drought, through the vulnerability and adaptation of a community to multiple stresses, to the vulnerability of humankind (or the global ecosystem) to all stresses and forces. Applications also vary by the phenomena of interest (biological, economic, social, etc.), and by time scale (instantaneous, months, years, decades, centuries). This paper looks closest at applications to human systems and human–environment systems, including communities, households, groups, sectors, regions and countries. While this focus includes the natural resource systems upon which societies depend, we do not review applications relating to the vulnerability and adaptation of physical or biological systems even though some of the concepts (particularly adaptation) have long, if contested, use in those fields (Smit et al., 2000; Smit and Pilifosova, 2003). It is in ecological systems that the resilience concepts have been most developed (Berkes et al., 2003; Holling, 2001; Gunderson and Holling, 2002). The resilience of ecosystems and socio-ecological systems is reviewed by Folke (2006).

Practical initiatives that tangibly address and improve societal adaptive capacity, thereby reducing vulnerability, are commonly expected to be evident at the community scale (Kates, 2000; Kelly and Adger, 2000; Ford and Smit, 2004). There are examples of international and national initiatives that have potential to contribute to the reduction of vulnerabilities of people, and their effects should be apparent in communities. For example, National Adaptation Plans of Action (NAPAs), if effectively implemented, should generate results evident in communities. *Community* is used here to mean some definable aggregation of households, interconnected in some way, and with a limited spatial extent, analgous to Coombes et al.'s (1988) use of the term "locality."

The following sections provide a brief overview of the concept of adaptation as it has been employed in a range of fields, and as it relates to adaptive capacity and vulnerability in the context of climate change. Then several purposes of adaptation analysis are distinguished in the climate change field, including one type of application that aims to contribute to actual adaptation strategies. The paper concludes with a review of analytical approaches which have been developed to facilitate this practical purpose.

2. Treatment of the adaptation concept

The term adaptation, as it is presently used in the global change field, has its origins in natural sciences, particularly evolutionary biology. Although the definition of adaptation in the natural sciences is disputed, it broadly refers to the development of genetic or behavioral characteristics which enable organisms or systems to cope with environmental changes in order to survive and reproduce (Futuyama, 1979; Winterhalder, 1980; Kitano, 2002). Individual adaptations (or adaptive features) are the features of organisms which have developed to ensure survival (Dobzhansky et al., 1977; O'Brien and Holland, 1992). Consideration of adaptation within natural sciences encompasses scales from the organism or individual to the population of a single species or an entire ecosystem (Krimbas, 2004).

The application of the term adaptation to human systems has been traced to the anthropologist and cultural ecologist Julian Steward, who used "cultural adaptation" to describe the adjustment of "culture cores" (i.e. regional societies) to the natural environment through subsistence activities (Butzer, 1989). O'Brien and Holland (1992, p. 37) define the process of adaptation as "one by which groups of people add new and improved methods of coping with the environment to their cultural repertoire". Denevan (1983, p. 401) considers (cultural) adaptation as a "process of change in response to a change in the physical environment or a change in internal stimuli, such as demography, economics and organization", thereby broadening the range of stresses to which human systems adapt beyond biophysical stress.

Social science treatment of adaptation in human systems has been concerned with "success" or survival of a culture. Anthropologists and archeologists suggest that adaptation is a consequence of selection acting on variation through cultural practices (adaptations) which have historically allowed a culture to survive (O'Brien and Holland, 1992). Cultural practices are thus equated with genetic characteristics in the natural sciences; in this Darwinian view, a group which does not have adequate methods of coping with environmental stress will not be able to compete for scarce resources and will fail to continue. In this treatment of the term, a cultural practice is an "adaptation" only if it developed to overcome stress, thereby distinguishing adaptations from "adaptive features" that allow societies to function within their environments regardless of whether or not they evolved as a result of selection (O'Brien and Holland, 1992).

In more recent social science work, cultural practices that allow societies to survive (and, beyond that, flourish) are considered adaptations which can be distinguished based on behavior and (technological) innovation (Denevan, 1983). It is recognized that societies adapt to a range of stimuli including, but not limited to, environmental stress. Cultures (or societies) which are able to respond to or cope with change quickly and easily are considered to have high "adaptability" or "capacity to adapt" (Denevan, 1983).

The concept of adaptation has been used both explicitly and implicitly in the social sciences, including in natural hazards, political ecology, and the entitlements and food security scholarship. Some scholars of adaptation have employed the concepts and terminology of biophysical ecological change with a focus on flows of matter, energy and information (e.g. Odum, 1970) and related concepts of resilience, equilibrium and adaptive management (e.g. Holling, 1986). Others, particularly in the natural