

Editorial

## Resilience, vulnerability, and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change

The concepts resilience, vulnerability, and adaptation are increasingly important for the study of the human dimensions of global environmental change. Events during the last 2 years, such as the hurricane Katrina, the Southeast Asian tsunami, and the Pakistan earthquake, together with the bird flu and continuing droughts in Africa, dramatically illustrate the potential vulnerability of human society to disturbances and variability. The concepts of resilience, vulnerability, and adaptation are used to analyze these and similar events. While these concepts are becoming more important within the global change research community, they do have diverse and somewhat separate intellectual histories.

In organizing this special issue, we initially experienced a Tower of Babel in hearing the diverse definitions made of core concepts. The diversity is largely explained by the distinct communities from which the concepts originate. As editors of this special issue, we have not aimed to impose a uniform language, but recognize the diversity of ways in which the terms and concepts are used. By bringing together the various insights on resilience, vulnerability, and adaptation, we hope to provide a comprehensive overview of diverse approaches. A typical example of the linguistic confusion is the use of socio-ecological systems (Gallopín et al., 1989), social-ecological systems (Berkes and Folke, 1998), and coupled human-environment systems (Turner et al., 2003). Although there may be some minor differences in the meanings of these terms, *all* emphasize the importance of including both social and ecological systems as well as their mutual interactions when studying their dynamics.

To understand the various concepts of resilience, vulnerability, and adaptation, it is important to know their intellectual histories, which is one of the goals of this issue. By understanding the origin and history of a term, linguistic confusion should slowly be reduced as the different scholarly communities begin to collaborate more and more. We hope this issue stimulates further collaboration among scholars from these diverse traditions.

*Resilience* is a core concept used by ecologists in their analysis of population ecology of plants and animals and in

the study of managing ecosystems. Holling (1973, p. 17) states that “resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist.” Ecologists have developed a strong body of theoretical and mathematical models. Since the late 1980s, the concept has increasingly been used in the analysis of human-environment interactions, mainly to describe and understand how humans affect the resilience of ecosystems.

The concept of *vulnerability* has its roots in the study of natural hazards and poverty. Vulnerability is defined in different ways, but it generally includes the attributes of persons or groups that enable them to cope with the impact of disturbances, like natural hazards. In the 1990s, natural hazards scholars started to focus on the vulnerability of people to impacts of environmental change, especially climate change. Geography provides the major disciplinary legacy. In contrast to scholars investigating the resilience of systems, there is little focus on mathematical models by scholars who examine vulnerability, but a greater focus on the comparative analysis of case studies.

*Adaptation* to environmental variability has been a focus of anthropologists since the early 1900s. In the 1990s, scholars began to use the term adaptation for the study of the consequences of human-induced climatic change, without explicitly relating this back to the conceptual origins in anthropology (e.g., see Adger et al., 2005). Adaptation is generally perceived to include an adjustment in social-ecological systems in response to actual, perceived, or expected environmental changes and their impacts. Case study analysis tends to be more prominent in this literature than mathematical modeling.

The first article in this special issue is a bibliometric analysis of the knowledge domains of resilience, vulnerability, and adaptation that have existed during the last 30 years. Janssen et al. (2006) analyze a database of 2286 relevant publications derived from the Institute of Scientific Information (ISI) online database on *Web of Science*. The

citations were collected and analyzed in terms of co-authorship relations and citation relations. The number of publications in the three knowledge domains increased rapidly during the last decade. The resilience knowledge domain is, however, only weakly connected with the other two domains in terms of co-authorships and citations. The resilience knowledge domain has a background in ecology and mathematics with a focus on theoretical models, while the vulnerability and adaptation knowledge domains have a background in geography and natural hazards research with a focus on case studies and climate change research. An increase in the number of cross citations and articles classified in multiple knowledge domains is occurring. This seems to indicate a slow integration of the different knowledge domains.

In the three “state of the art” articles presented in this special issue, Folke, Adger, and Smit and Wandel discuss in more depth the past, present, and future of the resilience, vulnerability, and adaptation concepts, respectively. Folke (2006) discusses the origins and recent developments in the area of resilience of ecological and social–ecological systems. The resilience approach emphasizes non-linear dynamics, thresholds, uncertainty, and surprise. It asks how periods of gradual change interplay with periods of rapid change and how such dynamics interact across temporal and spatial scales. The history was dominated by empirical observations of ecosystem dynamics interpreted in mathematical models, developing into the adaptive management approach for responding to ecosystem change. Serious attempts to integrate the social dimension are currently taking place in resilience work, reflected in the large numbers of sciences involved in explorative studies and new discoveries of linked social–ecological systems.

Adger (2006) reviews the research traditions related to the study of vulnerability to environmental change and the challenges for current vulnerability research in integrating with the domains of resilience and adaptation. Antecedent traditions include theories of vulnerability as entitlement failure and theories of hazard. Each of these areas has contributed to present formulations of vulnerability to environmental change as a characteristic of social–ecological systems linked to resilience. The challenges for vulnerability research are to develop robust and credible measures, to incorporate diverse methods that include perceptions of risk and vulnerability, and to incorporate governance research on the mechanisms that mediate vulnerability and promote adaptive action and resilience.

Smit and Wandel (2006) focus on the concept of adaptation and adaptive capacity in the context of vulnerability of human systems to global changes, especially climate change. They focus on scholarship that contributes to practical implementation of adaptations at the community scale. In numerous social science fields, adaptive capacity is considered to be the response to risks associated with the interaction of environmental hazards and human vulnerability. In the climate change field, adaptation analyses have been undertaken for several

distinct purposes. Impact assessments assume adaptations to estimated damages to longer-term climate scenarios with and without adjustments. 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.

From these “state of the art” overviews of the three core concepts, one learns about the different intellectual backgrounds, but also that they are beginning to use similar terms. For example, the term “adaptive capacity” is now a key term used in the resilience community, and the term “resilience” is now also used in the vulnerability community. Due to the different intellectual histories, these terms do not always have identical meaning. Gallopín (2006) provides a systemic perspective to identify and analyze the relations among the concepts of vulnerability, resilience, and adaptive capacity. These concepts are related in non-trivial ways. Therefore, efforts should be made to develop clear (and hopefully, mutually compatible) specifications of the concepts for use in abstract and field studies of ecological and social systems. Gallopín poses a set of diagnostic questions regarding how the three concepts are specified to help in the search for a shared conceptual framework to study the natural and social dimensions of global change. The development of a general theory of change and transformations of social–ecological systems is suggested as an important objective for the future research agenda on global change.

The article of Young et al. (2006) is an output of intense discussions related to the challenge of developing a future research agenda of the resilience, vulnerability, and adaptation of human and global environmental change processes. These discussions started at the Arizona workshop, and a topic that emerged centered on the implications of globalization on the resilience, vulnerability, and adaptability of social–ecological systems at scales ranging from local to global. The structure of the global social–ecological system is transforming due to changing connections at all scales. In earlier times, changes at a local level usually occurred more rapidly than changes at higher levels. Today, some developments are more rapid at higher levels, leaving the lower levels behind (as in the case of the changing institutions at the European Union level). People are more connected at a global scale, leading to a faster spread of information and infectious diseases. Diversity, whether it is biodiversity, language diversity, or institutional diversity, is decreasing. Globalization is not a new phenomenon, but it may be an important cross-cutting theme to address resilience, vulnerability, and adaptation of social–ecological systems at multiple scales.

We hope this special issue provides a good historical overview of developments in these three cross-cutting themes of the International Human Dimensions Program, as well as pointing to some of the important questions for future

research. Given the close interlinkage between social and ecological worlds, it is essential that scientists from all disciplines work together to increase the resilience and adaptability and reduce the vulnerability of these linked systems. We think this special issue will help move us all ahead.

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