A New Initiative on Vulnerability, Resilience and Adaptation

Sander E. van der Leeuw

Photo BCMom

In the winter of 2005, at the initiative of Elinor Ostrom and the IHDP Scienctific Committee, I organized a meeting at Arizona State University on the theme "Vulnerability, Resilience and Adaptation". The papers presented at the meeting – as well as a collective paper – were published in the autumn of 2006 in a special issue (vol 16:3) of Global Environmental Change, edited by Elinor Ostrom and Marco Janssen. On the basis of that result, in March 2007 the Scientific Committee decided to create a transversal theme across all IHDP core projects on this theme, and asked me to initiate that effort. This short contribution is intended as a brief report to the wider IHDP community, as well as an effort to reach out to all those researchers in our community that might be interested.

To clarify our main concerns and to set this article in a broader context, we resume a discussion of key concepts that was presented in the special issue. A broader discussion of these and similar concepts can be found elsewhere (Adger 2006; Folke 2006; Gallopin 2006; Janssen et al. 2006; Smit 2006).

In the literature that concerns us, the ideas of adaptation and adaptability are somewhat older than resilience and its sister concepts, robustness and vulnerability. In the life sciences, adaptation has a lengthy tradition, and was brought to prominence by Darwin and others in attempting to explain the genesis of diverse forms of life. In the social sciences, it dates back at least to the cultural ecology of the 1940s and 1950s (e.g. White, 1949; Steward, 1955). In these contexts, adaptation refers to the process of structural change in response to external circumstances. Adaptedness, then, refers to the extent to which a particular dynamic structure is effective in dealing with its environment, and adaptability refers to the capacity to adapt to future changes in the environment of the system concerned. Adaptation and adaptability have, moreover, a connotation of reaction to changing exogenous circumstances, whereas resilience, robustness, and vulnerability are more often used in a setting in which society and its environment are deemed to be interactive and, so, dynamic. Adaptation and adaptability are rather general concepts that do not point to the why and how of the underlying system dynamics. Resilience, robustness, and vulnerability point to structural characteristics of the systems concerned and to whether or not change is necessary for survival.

The concepts "resilience," "robustness," and "vulnerability" can only be understood in relation to one another (van der Leeuw, 2001). All three are properties of the combined socio-ecological system. Robustness is the most recent of these terms. Its intrinsic meanings are still under (sometimes heated) discussion (cf. www.santafe.edu/robustness)

In the present context, it seems to refer to the structural and other properties of a system that allow it to withstand the impact of disturbances with or without change (Anderies et al. 2004). Current levels of robustness, resilience, or vulnerability may be based on past adaptations. If these adaptations were highly specific, the system may need to adapt again upon encountering new types of disturbances (Carlson and Doyle, 2002). As defined by Holling (1973), by contrast, resilience refers to "the capacity of a system to absorb and utilize or even benefit from perturbations and changes that attain it, and so to persist without a qualitative change in the system's structure." Such a system may take new external conditions into account by absorbing them into its mode of functioning (Holling 1986). The difference between the two concepts thus seems to lie in the extent to which (non-structural) changes in dynamics may be introduced into a system under the impact of perturbations. Resilience allows for temporary changes in functioning and dynamics, as long as the system remains within the same stability domain. Vulnerability refers to situations in which neither robustness nor resilience enable a system to survive without structural changes. In such cases, either the system does change structurally or it is driven to extinction. All three terms express a temporary condition of the interaction between a system and its environment.

The terms resilience, vulnerability, and adaptability can be, and commonly are, used at all spatial and temporal levels in a dynamic structure, whether societal, environmental, or socio-ecological. They may refer to capacities of the system as a whole, but also to those of any one (or more) of its components, even down to the level of the individual actor.

To understand what makes a Social-Economic System (SES) resilient, robust, vulnerable, or adaptable, one must pay particular attention to two properties. The first is that in most systems, whether social or biophysical, external or internal disturbances trigger a number of reactions at different spatial and temporal scales. Which of these reactions eventually overcomes the disturbance, and what the impacts of the episode will be on the future dynamics of the system, depends on the persistence of the disturbance as well as on the size of its impact.

A clear example of the impact of an external disturbance on a Social-Economic System involves an agro–pastoral society experiencing drought. The impact of a drought is determined in part by the extent of the water shortage experienced by the crops, the animals, and the human population. One could say that the size of its impact can be quantified in terms of the "missing" amount of water at any one time and place, and the disturbance this lack of water causes in the subsistence and growth patterns of the plants, animals, and people involved.

The duration of the drought is another important variable. Ethnographic, historical, and archaeological observations confirm that in the first year, the population usually can survive even a serious drought by dipping into grain reserves and other resources. In the second year of a drought, those reserves are generally insufficient, and people will begin to slaughter some of their animals. Generally, in the third year they slaughter so many of these that, in the fourth year, the long–term survival of the group is threatened. Unless they migrate to better lands, or disband as a group, or institute other structural changes ("borrowing" from a neighboring group, for example, which generally leads to long-term exchange relations), they face collective death. Thus, if in the first year, the group's subsistence dynamics are sufficiently robust to cope with the drought with only minor adjustments, in the second year the group survives on its resilience or, in other words, by relinquishing part of the resources that serve as a long-term "backbone" to its way of life. In the third year, the group becomes vulnerable to further mishaps, and if nothing structural is done, the group ceases to exist in the fourth year. Thus, the temporal scale of a perturbation, as well as the scale of the system's own dynamics, is an important measure of the system's adaptive capacity, robustness, resilience, and vulnerability. In this respect, SESs do not differ from purely biophysical or purely social systems. In addition to the temporal scale, the spatial scale of the phenomenon determines how many people (or animals, crops, etc.) are involved in the disaster, and, indirectly, how long it will take for natural restorative processes (demographic processes, re–colonization of the vegetation, etc.) to overcome the damage done. Compared with the problems we must come to terms with today, this example is extremely simple. Yet its very simplicity helps to clarify the meaning of resilience, vulnerability, and adaptability in coupled socio-ecological systems.

In improving our understanding of the differences between anthropogenic and biophysical system dynamics, an important difference is that people and organizations are capable of learning, and learning how to learn (Bateson 1972). They communicate by means of self-referentially negotiated

symbols (Luhman 1985), and act individually as well as in conjunction with others. They have the capacity to create objects, informing a wide range of substances, and substantiating a wide range of forms.

Relative to their lifespans, human societies, therefore, have a variety of very rapid adaptive dynamics at their disposal. These have enabled them to insert themselves into the dynamic structure of biophysical systems to the extent that the latter have, in the true sense of the word, become socio-ecological. In the process, many human societies have exchanged external (environmental) for internal (societal) complexity. They have homogenized parts of their environment in order to bring their dynamics under control, as in the cases of deforestation, cultivation, and grazing. Over the last 10,000 years, the survival of SESs has therefore become increasingly dependent on the resilience of their social dynamics in contrast to their purely biophysical dynamics. This is particularly clear in "old" settled areas, such as the Mediterranean Basin (Naveh & Liebermann, 1984; van der Leeuw 1998) and the Swiss Alps (Netting, 1981).

The counterpart to this is that they have transformed the spectrum of dangerous or threatening situations in which they intervene (van der Leeuw, 2001). This is due to the fact that they have acted to dampen or remove risks that occur frequently. Such interventions are based on a reduced image of the dynamics involved, in which the short time-scales predominate. In the process, a range of new (unknown) dynamics at different timescales may be introduced, including (very) long ones that are hard to detect in the short run. The net effect is that more and more frequent threats are brought under control, while new, infrequent dangers are created. Though this may for some time create an appearance of control, the accumulation of longer–term threats undermines that stability "unseen." Eventually, the longer–term dangers emerge, leading to what may be perceived as a "crisis," such as the fluctuations of world oil prices in the face of perceived scarcity. Such crises are inevitable in Social-Economic Systems, because the substitution of complexity internal to social systems for external complexity will remain incomplete. Mismatches, discontinuities, non-linearities, and thresholds are likely to be revealed as this process of substitution unfolds.

How are we proposing to launch the initiative?

In conversations with the Resilience Alliance and the Stockholm Resilience Institute, as well as various members of the IHDP SC, it appeared that on both sides, in the Resilience Alliance and in IHDP, that there are complementary reasons to launch such a joint initiative. On the side of the Resilience Alliance, there is the desire to approach a wider international audience of potentially interested scientists, while on the side of IHDP, this move aims to further development of one or more unifying conceptual approaches to the work that is being done in the Core Projects and the Projects co-sponsored with partner organizations (IGBP, WCRP).

It seems most efficient to initially grow this theme from three existing research centers heavily involved in thinking about resilience: the Stockholm Resilience Centre (Sweden), the Tyndall Centre (Norwich and Oxford, U.K.) and Arizona State University (U.S.A.). In effect, these are among the centers most heavily involved in both IHDP and the Resilience Alliance, and have many members in both organizations.

Two evident occasions offer themselves to give more visibility to this initiative in the coming year. First of all, the Stockholm Resilience Centre is holding a major conference on Resilience on April 14-17, 2008. IHDP is planning to co-organize a workshop session there, together with the Resilience Alliance. IHDP will also draw attention to this initiative in one of the plenary sessions, and have a presence in one of the poster sessions. Conversely, IHDP, the Resilience Alliance and the Stockholm Resilience Centre will organize a joint session at the IHDP Open Meeting in Delhi (India), 15-19 October 2008, and offer poster and booth facilities to the Resilience Alliance. We are currently in the process of preparing for both events.

IHDP-affiliate researchers are encouraged to consult the above-mentioned issue of Global Environmental Change and the website of the Resilience Alliance (www.resalliance.org) to learn more about the conceptual framework involved. Officers and participants in any of the IHDP Core Projects who are interested in the approach and intend to attend either of the two meetings mentioned, are encouraged to email me (vanderle@asu.edu), or consult the Resilience Center's (www.stockholmresilience.su.se) or the IHDP's (either www.ihdp.uni-bonn.de or www.openmeeting2008.org) websites, depending on the conference they plan to attend.

Sander E. van der Leeuw, *Arizona State University and Santa Fe Institute.* Contact: School of Human Evolution and Social Change, Arizona State University, P.O. Box 872402, Tempe, AZ 85287-2402, USA. E-mail: vanderle@asu.edu