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Vulnerability and Global Environmental Change: Rhetoric and Reality

Global environmental change includes transformations of both societal and biophysical systems as the result of human activities. The human consequences of environmental change are products of the vulnerability and sensitivity of social and environmental systems. Improved scientific understanding of vulnerability in all its dimensions is necessary if we are to find appropriate ways to reduce heightened vulnerability, and also to improve understanding of how enhanced vulnerabilities may act as triggers to complex environmental feedbacks in the earth system. In this AVISO issue, we establish the policy context by exploring some of the current use and wider discourse around vulnerability from scientific and user-community perspectives. We also explore the linkages between vulnerability and human security. We conclude with recommendations on how to use vulnerability as a means of improving human capacity to manage risks of environmental change.

The term "vulnerability" appears with increasing frequency in the global environmental change literature as well as in discussions of human development, food security, and natural hazards. Nevertheless, the concept is somewhat fuzzy and often difficult to use effectively in science and wider policy¹ contexts. Coupled to the scientific debate surrounding the definition and use of vulnerability are similar

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discussions, for example, related to such concepts as resilience and adaptive capacity to environmental change. Although the relationships between resilience, adaptive capacity and vulnerability are still being explored, some would argue that resilience increases the capacity to cope with stress and hence serves as a *loose* antonym for vulnerability. Others argue that human security represents the opposite of vulnerability. Despite the apparent lack of clarity of which term is the best to use, there is widespread acknowledgement that vulnerability is central to discussions of sustainable development and a critical issue for a variety of stakeholders.

The Contextual and Dynamic Nature of Vulnerability

Vulnerability is not a new concept or paradigm; it has been part of scholarly and policy discussions for several decades. What is new, however, is the expanded use to which the concept has been applied by disaster managers, development practitioners, and global change scientists, among others.

Most definitions of vulnerability include the idea of potential damage or adverse outcomes in relation to an external stress, a process, or an event. The stress,

¹ Policy is used here in a broad context including not only 'government' but also wider civil society, NGOs, and others that constitute the broader policy community.

process, or event is usually referred to as an external agent, and it varies according to the context of the study or assessment (e.g., climate change, land degradation, or pollution).

Although vulnerability is sometimes discussed in the abstract, it is usually associated with one or more processes, explicitly answering the question “vulnerable to what?” Blaikie *et al.* (1994, p. 9), for example, define vulnerability as “the characteristics of a person or group in terms of their *capacity to anticipate, cope with, resist and recover from the impacts of natural hazard.*”

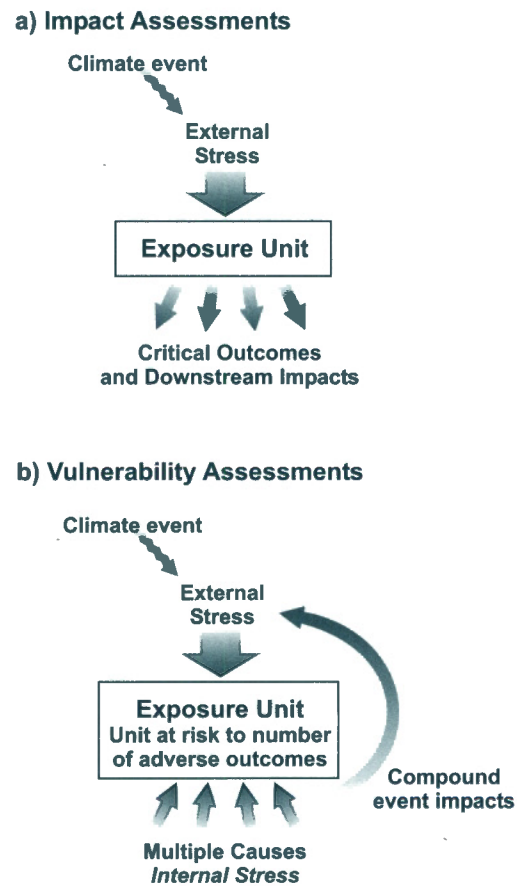
Vulnerability is not, however, a predetermined state, but instead is usually socially constructed, contextual, dynamic and driven by various causal agents and processes. Changing social and environmental conditions such as urbanization and deforestation, for example, can influence vulnerability. Vulnerability is also often the result of interacting stresses and pressures that vary across regions. The spread of HIV/AIDS, for example, is increasing potential vulnerability to global environmental change in sub-Saharan Africa by impacting the local labor force and reducing local adaptive capacities. The consequences of these multiple stressors were visible in the 2002/2003 ‘famine’ in southern Africa and are currently being unveiled by severe drought in parts of the region.

Vulnerability is a relative term, and within any society, wealthy or poor, some members are likely to be more vulnerable than others. Although a community may face the same risk, all members will not be equally vulnerable. Despite the obvious linkages of vulnerability to climate variability, the allocation of risk and differential vulnerabilities to global environmental change is also structurally determined, with vulnerability often being unevenly distributed across society. Furthermore, the meaning and interpretation of vulnerability differs across societies and contexts, depending on particular values. For example, vulnerability to climate variability may be expressed in terms of insurance payments and infrastructure losses in a wealthy coastal resort or in terms of lives lost and hunger in a densely populated housing development located in a flood zone. Although contexts are different, vulnerability remains a concern in both cases. Therefore, capturing the differential elements of vulnerability is a prerequisite for the formulation and implementation of policies that will promote equitable and sustainable development.

Moving from Impact to Vulnerability Assessments

Effective response to vulnerability will require multi-faceted strategies. Traditionally, *impact assessments* have been used to gain some indication of responses to risk. Such assessments have usually focused on downstream impacts, which may include both biophysical and socio-economic elements. Impact assessments are used to document potential consequences of environmental change, and are exemplified by various national and international assessments, including those carried out by the Intergovernmental Panel on Climate Change (IPCC). A particular event (e.g., drought) or human action (e.g., construction of a large reservoir), for example, is selected for assessment and the residual impacts that result from the action or event are then tracked, either from an ecosystem or social perspective (see Figure 1a).

Figure 1: From impact assessments (a) to vulnerability assessments (b).



Vulnerability assessments (see Figure 1b), however, turn this approach around and concentrate on the factors (both environmental and human) that, together or separately, drive and shape the vulnerability of the receptor (e.g., a community or a landscape). The potential risks for either the social group or ecosystem are then assessed in the face of a variety of stress events, and in light of the ability of the receiving ecosystem or social group to respond (i.e., the internal coping dimension). The combined causal factors that contribute to an exposure unit's coping capacity thus become as important as, if not more important than, the external environmental stress contributing to risk.

The example of drought can be used to illustrate the difference between impact assessments and vulnerability assessments. On the one hand, drought in a region is usually driven by rainfall failure and higher than average temperatures associated with changes in atmospheric dynamics. An impact assessment, using climate variability as cause, usually then focuses on the consequences of this drought for various sectors, most notably crop production and agricultural income. On the other hand, the region's vulnerability to drought may be influenced by years of environmental degradation, past or present economic policies (e.g., structural adjustments), and erosion of social capital and intricate support mechanisms over time. In some areas, conflict and war may further compound vulnerability to drought. The exposure unit (e.g., ecosystem and/or social group) thus is weakened by a set of drivers or causal mechanisms that together with the climate hazard contributes to the vulnerability of that community. Box 1 shows an example of triggers heightening vulnerability in a famine-prone region in southern Africa, with some policy options to promote mitigation and adaptation. Notwithstanding the difficulties in capturing the dynamics, complexity, and scale of vulnerability, a number of approaches and methods exist for assessing vulnerability. These have been proposed and undertaken by a wide variety of practitioners, including disaster managers and humanitarian workers. Academic

narratives developed alongside these practical assessments have influenced funding and development agencies and politicians, such as Britain's Department for International Development (DFID) or the World Bank. Three common approaches to vulnerability assessments are described below:

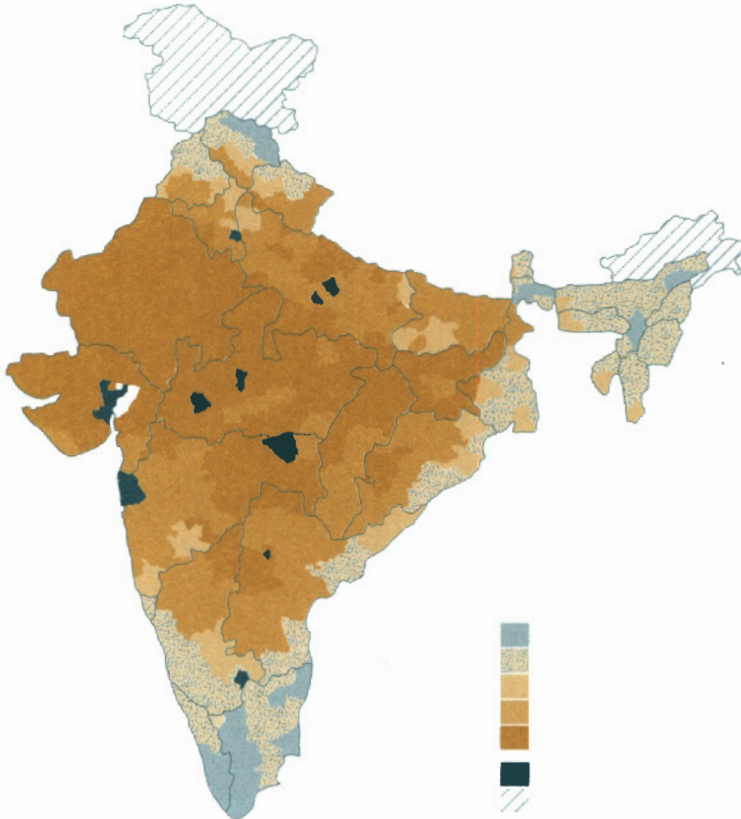
The indicator approach:

The point of departure for these vulnerability assessments is a specific set or combination of indicators used to measure vulnerability, such as x , y , z . Indicator approaches can be used at virtually any scale (e.g., household, system, state), but they are often unable to capture the complex temporal and spatial dynamics, as described earlier. Examples of this approach include Ramachandran's and Eastman's mapping of West African food security indicators, and Lonergan *et al.*'s Index of Human Insecurity (IHI) that assists policy and aids decision-makers in development efforts to identify vulnerable or insecure regions. A mapping of the vulnerability of Indian agriculture to climate change includes both indicators of climate sensitivity (dryness and monsoon dependency under projected $2\times\text{CO}_2$ conditions) and adaptive capacity (biophysical, socioeconomic and technological factors). The resulting vulnerability map (see Figure 2) demonstrates that the districts most likely to be affected by climate change are not necessarily the most vulnerable.

Box 1: Some 'triggers' or factors enhancing vulnerability to famine in southern Africa and some mitigation and adaptation options.

Triggers	Long-term Mitigation and Adaptation
Drought driven by El Nino	Effective use and distribution of seasonal forecasts
Rainfall failure	Rain water harvesting
Insidious drivers	
Governance failure	Effective institutional co-ordination (e.g., Departments of Welfare, Agriculture, Water).
Prevailing poverty	Social programs for support to child headed households, enabling environment for diversification of livelihood strategies.

Figure 2: Vulnerability of Indian agriculture to climate change



Source: O'Brien et al. 2004

Sustainable livelihoods framework:

This framework looks at both hazards (e.g., droughts and floods) and the myriad of other 'drivers' that may enhance or reduce vulnerability. The sustainable livelihoods framework usually links together a stressor on the one hand (e.g., a shock such as drought) to a range of other factors (e.g., institutions) and is used to examine how these factors impact on vulnerability. The inter-connections and interplay of these factors are usually tracked with reference to their impact on various capitals (e.g., social and physical capital). This approach is people-centered and tries to examine how people operate within a vulnerability context (e.g., within certain constraining and enabling environments including economic shocks and other longer term trends). How people construct a livelihood in these contexts is therefore determined by their ability to draw on various assets they may have within a vulnerability context, framed by a range of institutions and processes.

Household and detailed food economy approaches:

These vulnerability assessments usually try to identify numbers and locations of people who are vulnerable to food insecurity and famine, classifying them as slightly, moderately, highly or extremely vulnerable. Household assets, including income, are typically used as the framework for vulnerability analysis. Households are divided into socio-economic groups and data are sought on demography, agricultural production, remotely sensed data, rainfall and market data and other assets. These data are often combined with anecdotal data (obtained from focal group discussions or participatory research) to draw information on current levels of vulnerability in the various groups relative to a baseline vulnerability. Examples of this approach include RiskMap as used by Save the Children Fund, and Vulnerability Assessment Mapping (VAM) and recent Vulnerability Assessment Committees (VAC).

Despite these differences in approaches and usage of nomenclatures, and their different policy implications, there are three defining features of vulnerability. First, vulnerability is inherently a *differential concept* because risks or changes and abilities to cope vary across physical space and among and within social groups. Although a region may not be considered vulnerable to environmental change, there are likely to be households or groups within that region that are indeed vulnerable. Second, vulnerability is *scale-dependent*, both across time and space. That is, it varies depending on the unit of analysis, from 'individual' or 'household' to 'class,' 'region,' or 'system.' Third, *vulnerability is dynamic*, in that the characteristics that shape vulnerability change over time, in response to changing biophysical and socio-economic conditions. Effectively capturing these various features of vulnerability remains a critical area of investigation both for scientists and for end-users of the science (e.g., humanitarian agencies, disaster practitioners). Having considered the various approaches and methods to measure vulnerability, the policy relevant issues are discussed below.

Vulnerability Contributions to Policy Agendas

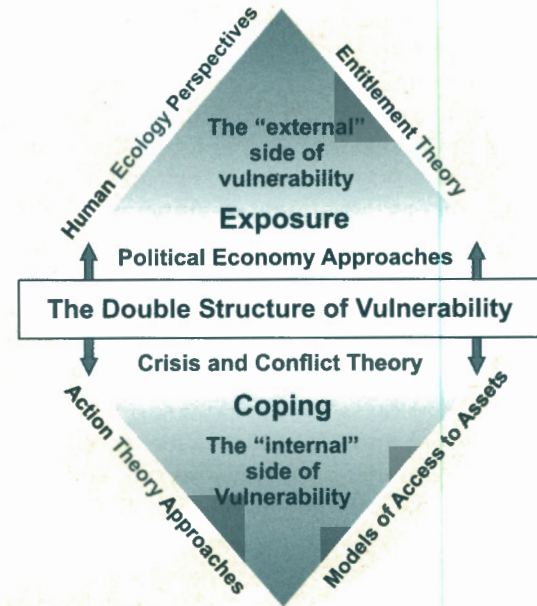
Vulnerability, then, is sensitive to external and internal factors (see Figure 3) that vary across time,

either seasonally (e.g., for farmers), instantly (e.g., with a rapid onset 'disaster' such as a volcanic eruption) and/or progressively (e.g., associated with past and present development issues such as structural adjustment, globalization, HIV). Usually it is the underlying, longer-term factors coupled to development and other socio-economic variables that contribute to vulnerability.

The various practitioners and scientists engaged in global change research come from different disciplines, bringing with them the nuances and approaches associated with their respective fields. Consequently, there has been much debate aimed at clarifying what users mean by 'vulnerability' and, more importantly, 'resilience' and/or 'adaptive capacity.' Within human dimensions research in particular, vulnerability has been discussed in relation to poverty, risk, coping capacity, adaptability, assets and entitlements, and other features or characteristics of human society.

These differences in perspectives have different policy implications. For example, some assessments

Figure 3: The double structure of vulnerability



Source: adapted from Bohle, 2001

Box 2: Differences between coping and adaptation.

Coping versus Adapting

Coping capacity and adaptive capacity are similar in that they both represent the internal side of vulnerability. They differ, however, in temporal scale and scope. Coping usually refers to short-term responses to a hazard or stress, whereas adaptation implies a longer-term process whereby an array of measures have been adopted to reduce sensitivity and vulnerability to a hazard or stress. Indeed, for many (e.g., the rural poor living on the margins, the urban poor living in hazardous areas, those suffering from severe malnutrition and hunger, those living in areas torn by conflict, and those at risk of HIV/AIDS), shorter-term coping with global environmental change may become increasingly difficult as social networks and strategies that were used in the past gradually become eroded.

Adaptive capacity often involves structural changes, and is mediated and shaped by a host of factors, including formal and informal institutions at the household to national to global scale. The notion of adaptive capacity has also received attention in the management of complex, biophysical environments where it reflects the degree to which a landscape or ecosystem can be effectively managed to 'positively' respond to an external stress. In other words, adaptive capacity refers to the resilience of the socio-ecological landscape.

Building adaptive capacity and mitigation also involves considerations of capacities across a range of scales. Thus the use of the word in 'Kyoto Protocol' language may imply different interventions and mitigation strategies to those who use the word 'adaptive capacity' and 'mitigation' at a very local level. Discussion of adaptive carbon emissions strategies may thus be used with a more 'global' perspective in mind, whereas for those working for a humanitarian organization, the use of the word adaptive capacity may mean improving local livelihoods through improved HIV advocacy and treatment campaigns. There is thus a need, particularly for policy makers and a variety of stakeholders, to be clear about their use of the words 'vulnerability' and 'resilience,' as well as the contexts in which these words and associated interventions are used.

that use a vulnerability perspective focus on exposure to a stress or event and emphasize the element of 'risk:' that is, vulnerable areas or groups are predisposed to *risk*, broadly defined as 'the chance of a defined hazard occurring.' In the simplest terms, vulnerability is thus considered equal to the risk (potential loss) in relation to the hazard (e.g., drought or flood). A policy instrument that builds on this understanding of vulnerability thus might target high-risk regions or groups, with the objective of minimizing the risk or hazard, or the consequential impacts. Other assessments of vulnerability include not only exposure to a risk or hazard, but also to the capacity to cope or adapt to it (see Box 2).

Abilities to cope and adapt are, moreover, influenced by various institutional dimensions or 'institutional architecture' that in turn will determine how a group or ecosystem can respond to change. From this perspective, a vulnerability assessment would not only focus on the exposure and sensitivity to a risk or hazard, but it would also integrate approaches from various social science disciplines to explain other factors determining adaptive capacity.

Often a country, for example, has a disaster management strategy in place. However, due to lack of careful thought around the institutional co-ordination between departments and implementation, a 'crisis' management response to issues associated with global environmental change prevails. Policy can therefore add to the complexity of the system/societal response to change and, depending on the type of measures and/or policies introduced, can ultimately limit or enhance exposure, sensitivity and risk to global environmental change.

Vulnerability is therefore directly relevant and applicable to a number of policy issues concerning human security and development. It can be used to identify regions and assess groups at risk from the seven categories of threats that fall under human security (see Box 3). It can also be useful for identifying "hot spots" and assisting in development planning, food relief efforts, and climate adaptation strategies. Yet incorporating

insights from vulnerability analyses into policy and practice remains a challenge, and there remains a lack of correspondence between vulnerability theory and action. This gap is illustrated by the recurrent food shortages and potential famines in southern Africa, an area where vulnerability assessments are often undertaken (e.g., by Save the Children Fund, OXFAM, CARE, regional VAC). Because these are not mainstreamed into wider development planning the efforts, however, and results are often sporadic and usually short-lived. The weak links between analyses and decision-making suggest that the institutional context for reducing vulnerability is underdeveloped, and that the current notions of vulnerability are too narrow and lack the ability to capture the dynamism in a system.

With all the renewed activity and interest surrounding vulnerability science, one would expect 'vulnerabilities' to decrease, while appropriate interventions to 'build adaptive capacity' would be expected to increase. This, however, does not seem to be the case in many regions. In fact, the incongruity between theory and action elicits the following

Box 3: Vulnerability-Human Security Relationships

Vulnerability approaches can be used to assess the seven categories of threats that fall under human security. Within the context of each category, any assessment must consider the question, "vulnerable to what?"

- Economic security (assured basic income) – vulnerability to global economic changes
- Food security (physical, economic and social access to food) – vulnerability to extreme events, agricultural changes, etc.
- Health security (relative freedom from disease and infection) – vulnerability to disease
- Environmental security (access to sanitary water supply, clean air and a non-degraded land system) – vulnerability to pollution and land degradation
- Personal security (security from physical violence and threats) – vulnerability to conflicts, natural hazards, creeping 'disasters' (e.g., HIV/AIDS)
- Community security (security of cultural integrity) – vulnerability to cultural globalization
- Political security (protection of basic human rights and freedoms) – vulnerability to conflicts and warfare

questions for both scientists and policy makers to consider:

- How can vulnerability science contribute to a better understanding of complex daily realities?
- Do vulnerability assessments need to pay greater attention to the institutional context within which decisions are made (e.g., issues of social justice) to provide policy-makers with a more realistic range of options for reducing vulnerability?
- Do current conceptualizations of vulnerability contribute to 'meaningful' enhanced human security, or are they merely a way of categorizing and differentiating the winners and losers under global change?

At the same time as the scientific community moves towards more dynamic, contextual, and complex analyses, the practitioner community requires quick and effective actions that can reduce vulnerability. In order to make a difference, scientists should be able to, at the end of the day, say something more than "it is very complex." Critical aspects of vulnerability should be identified. While general prescriptions such as reducing poverty may serve as a way to reduce vulnerability, concrete actions should also be identified. Given the growing interest and attention to the concept of vulnerability, it is perhaps timely to address the gap between theory and action.

Advancing the Policy-Relevance of Vulnerability Studies

As is evident from some of the cases and activities cited above, vulnerability and resilience in global environmental change research have become important locus points in the science of global change. Some suggest that these are just more 'sexy topics' currently used to garner research funds. Notwithstanding these critiques, there remains an urgent need to synthesize and conduct assessments that will be of use to those trying to live with the various attendant risks that will accompany environmental change. As indicated here much has been done, and much valuable discussion has occurred. Despite these activities, several regions in the world, where this science could be more effectively used, are currently at risk and are likely to become more at risk to global change in the future.

To make vulnerability more useful to policy and decision makers, there is a need to extend analyses to cover more sectors and facets of vulnerability, including urban vulnerabilities, vulnerabilities to changing water supply, and vulnerabilities to infectious

diseases. There is also a need to explore the linkages between causal agents, structures, and institutions that may enhance or constrain vulnerability, as well as to find the most effective mix of 'scales' at which to intervene. A balanced vulnerability agenda emphasizes the need to address underlying social, economic, and environmental issues, which heighten human vulnerabilities in developing and developed, urban and rural contexts. The need for more effective collaboration between scientists, policy makers, and development practitioners is no longer an indulgent academic luxury but a pressing imperative.

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GECHS

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The GECHS project involves activities including research projects, workshops, training activities, publications and policy briefings.

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