

## **Vulnerability and global environmental change**

### **DRAFT PAPER**

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Global change is the product of both climate change and a host of other activities. Recent synthesis work on the Earth System, for example, includes both the role of climate and human action in shaping Global Change (IGBP Science 4, 2001). “Research on the human dimensions of global change concerns human activities that alter the Earth’s environment, the driving forces of those activities, the consequences of environmental change for societies and economies, and human responses to the experience or expectation of global change” (National Research Council, 1999, 1). Allied to this research is the notion of vulnerability that is increasingly being framed in several arenas (e.g. humanitarian ‘disaster management and risk reduction’, hazards research, global change community):

“Understanding sensitivity and vulnerability to environmental variations and changes. The human consequences of environmental change depend as much on sensitivity and vulnerability of social systems and on their ability to adapt as on the environmental changes they experience. This research should include a focus on the characteristics of social systems that make them sensitive or vulnerable to particular environmental changes ...” (National Research Council, 1999, 65).

In this brief presentation, vulnerability is described and an overview of the ‘science’ given. Various practitioners and scientists engaged in the ‘science’ usually bring with them different nuances of ‘vulnerability’ both in their understanding of the term and in their attempts to measure and map vulnerability. Some of these are also described in the paper. Finally, some suggestions for improved ‘vulnerability’ measures and use are given.

## **Grasping vulnerability: what does it mean?**

There have been several attempts at defining and capturing what is meant by vulnerability (see the following for good overviews of vulnerability e.g. Liverman, 1990, 1992; Dow, 1992; Watts and Bohle, 1993; Cutter, 1996; Kasperson and Kasperson, 2001). Vulnerability, as evident from the above examples, is a fundamental aspect of global environmental change. While the term vulnerability is used in a number of contexts (e.g. medical science and biophysical sciences) it is increasingly being viewed through the lens of the social sciences (Chambers, 1989; Liverman, 1990, 1992; Dow, 1992; Watts and Bohle, 1993; Blaikie *et al.*, 1994; Kasperson *et al.*, 1995). Some view poverty and vulnerability, for example, as one and the same while others equate vulnerability with certain kinds of production systems (Parry and Carter, 1987). Watts and Bohle (1993, 46) indeed call for a refinement of our understanding of vulnerability and argue that the local and historical configurations of poverty, hunger and famine define for them what is called a space of vulnerability:

"...vulnerability is a multi-layered and multi-dimensional social space defined by determinate political, economic and institutional capabilities of people in specific places at specific times".

Vulnerability or vulnerable groups thus implies some form of external dimension that may increasingly predispose people to *risk* and hence heighten vulnerability but also includes important internal elements (e.g. Chambers, 1989) such as defencelessness and a lack of means to cope with damaging loss. Risk is closely tied to vulnerability and can be seen as a function of vulnerability. Communities who are most vulnerable will also probably be those most at risk to shock or disturbance to normal daily life. Although communities may face the same risk they will not, however, be equally vulnerable. Vulnerability, therefore, is not merely poverty (Kates and Haarmann, 1992). In its broadest sense risk may be defined as 'the chance of a defined hazard occurring.' Where data are available, modelling and fairly quantitative assessments of risk can be undertaken. However, the difference between risk and uncertainty, as Scoones (1996) highlights, is often blurred in practise. The ways that people respond to risks are also not reducible to a product of probabilities: values, preferences and normative judgements inevitably intervene and perceptions guide people's responses (Scoones, 1996).

There is, moreover, a complex interaction between the exogenous (external threat/event) and the internal capacity of a community or household to withstand or respond to the event. While the focus for much of the debate around vulnerability is focused on risk and what predisposes people to risk, some have also called for a much closer examination of the factors influencing the 'capacity' to withstand change (e.g. Anderson and Woodrow, 1989, 1993; Watts and Bohle, 1993; Blaikie *et al.*, 1994; Kasperson, *et al.*, 1995; Berkes and Folke, 1998; Bohle, 2001). Blaikie *et al.* (1994), for example, thus 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*" (Blaikie *et al.*, 1994, 9). Anderson and Woodrow (1989) suggest three categories that are used when trying to understand and identify dimensions of vulnerability and capacity including physical and material, social and organizational and motivational and attitudinal.

Coping capacity (usually in the short term) and/or adaptive capacity (usually viewed as occurring over longer time frames) (e.g. Davies, 2000) is, however, a highly complex issue. Bohle indeed identifies three conceptual and theoretical strands to the conceptual model of coping (Bohle, 2001). They are action-orientated approaches, models of access to assets and crisis and conflict theory. In the first strand, an understanding of 'structure and agency' is required. For example, to what extent do food-insecure people have a bundle of options to cope with food crisis or to what extent are their coping strategies determined by structural constraints.

The second strand i.e. access to assets, focuses on understanding the role that access to various assets (including personal, economic, socio-political, infrastructural assets) plays in vulnerability. The more assets and access to assets a group have the less vulnerable they are. Social assets here play a particularly important role, for such assets are often the only form of 'coping' that a group is left with during a period of heightened risk. Most poor people, moreover, choose a wide variety of options to try and increase their adaptability or minimize their risk to times of stress and shock (Chambers, 1989) and try and diversify their interests (e.g. Swift has indicated that this may include assets investments, stores and claims) (Swift, 1989). Households have portfolios of investments, stores etc. which can and are often drawn down during times of stress. There are also differences in risk-minimizing responses along class lines with poorer households usually compelled to dispose of larger assets earlier on e.g. cattle than relatively richer households that have more options (Taal, 1989).

The third strand that Bohle (2001) teases out is that of crisis and conflict theory where access to control over resources is shown to occur usually in highly contested 'spaces' and 'arenas'. Empowerment aspects of vulnerability and the power relationships

and rights that are exercised within a particular setting (e.g. Watts and Bohle, 1993) are therefore also key determinants of vulnerability. Thus in terms of household food security, one would seek to identify the complex configurations of rights exercised along generational and gender lines to food and other resources (Watts and Bohle, 1993). Questions that could be raised include what are the rules by which claims can be made over resources? How do different social actors gain access to and control over various resources (see Leach, Mearns and Scoones, 1997 for more info on this aspect)? Reductions in the ability to overcome or enhance one's security is also another key issue that emerges from much of the local assessments of vulnerability. The reduction of the *range of options, assets and risk-reducing activities* can often heighten vulnerability (see e.g. Scoones, 1996). These two dimensions of vulnerability, namely exposure and coping are what Bohle has defined as "the double structure of vulnerability" (Bohle, 2001, 4).

Comprehensive discussions on these various aspects of vulnerability have been undertaken (see for example, Swift, 1989; Downing, 1991, 1992; Davies, 1996; Moser, 1996; Scoones, 1996; Bohle, 2001) details of which fall outside the ambit of this brief paper. One important issue, however, emerging from these discussions, is that our notions of assets and capacities to reduce risk should not be narrow and static. Assets and risk-reducing activities are often transformed by the vulnerable through expansion of existing strategies or through diversification (Naerra *et al.*, 1993; Pyle and Gabbar, 1993; Scoones, 1996) and replacement activities and are constantly undergoing change over time.

Definitions of vulnerability therefore depend on a number of factors. Kasperson and Kasperson (2001) have summarised some of these defining features of vulnerability to be: 1) vulnerability can be viewed as comprising internal characteristics of the subject and external processes contributing to differential exposure; 2) vulnerability is understood as relative to a given hazard; thus the degree of vulnerability will differ among hazards of varying kind and magnitude; and 3) the unit of analysis varies in scale as suggested by the range from 'system' to 'class' to 'household' and to the 'pressure-release' classification of increasing pressure from both rising vulnerability and the severity of the hazard (e.g. Blaikie *et al.*, 1994).

### **Measuring vulnerability**

Having briefly introduced discussion on aspects of vulnerability, risk and capacity, attention now shifts to examine methods of capturing vulnerability. Several efforts at capturing or 'mapping' vulnerability and developing indicators of vulnerability have been undertaken. These tasks are not easy to do and will ..."need to be rich in their cross-scale analyses, for

the multiple stresses that bear upon vulnerable regions often emanate from higher scales” (Kasperson, 2001, 2). For ease of discussion, attempts to measure, map and understand vulnerability are clustered below from varying perspectives and from the interests of varying practitioners: including e.g. social vulnerability assessments; disaster management perspectives; the humanitarian perspective and the climate change perspective. These are not meant to be exclusive and commonalities between clusters will occur.

### *Social assessment*

Some of the social aspects of vulnerability were outlined above (i.e. the structural elements of vulnerability). These assessments have been influenced by Sen (1989, Chambers (1989) and others. More recent concerns have included the need to focus on aspects of globalization and an orientation to capturing dynamic vulnerability rather than only limiting the analysis to a traditional or static approach. Leichenko and O’Brien (2001), for example, suggest that patterns of vulnerability have become increasingly dynamic and linked to economic globalisation. Economic globalisation is exposing many rural regions to global markets:

“... dynamic vulnerability considers how global and macro-scale changes are being played out at regional and local scales...economic globalization in particular is exposing many rural regions to global markets leaving many areas, sectors and social groups doubly exposed to the impacts of globalization and climate change...” (Leichenko and O’Brien, 2001).

More recent research in exploring vulnerability into larger economic and institutional contexts is continuing (e.g. Adger and Kelly, 1999; Handmer, Dovers and Downing, 1999; Reilly and Schmmelpfennig, 1999; Ostrom, 2001). Economic changes associated with globalization, for example, are altering conditions for the production and marketing of agricultural products. National-level reforms in agricultural policies, such as the elimination of subsidies and price support or changes in agricultural research and extension thus may have differentiated impacts on developing farmers (Leichenko and O’Brien, 2001). Such technological and institutional factors and changes may shape new vulnerabilities. Leichenko and O’Brien (2001) suggest that a set of macro vulnerability indicators need to be combined with local-level survey-based investigations of how economic policies are affecting the agricultural sector and other sectors in the face of economic and possible climate change (Table 1) (Ramachandran and Eastman, 1997).

### *Disaster Management – measures of vulnerability and the search for indicators*

Much effort, largely initiated through the International Decade for Natural Disaster Reduction (IDNDR), has also focussed attention on vulnerability. The expansion of concern into this area has seen a broadening of perspective from a civil protection approach to disasters to a more pro-active focus that includes vulnerability and risk reduction activities. A number of technical committees during the IDNDR were formed with one, for example, being tasked specifically to address Vulnerable Communities. Poverty, population growth and environmental degradation together with the ‘vulnerability of institutions and structures on which people depend’ were identified as key factors heightening vulnerability to disasters (IFRC and UNICEF, 1994).

The community and practitioners in this field have not only focussed on hazards as factors in disasters but through their efforts have begun to tease out various aspects that shape vulnerability and have begun to describe how these heighten disaster risk. Research and interrogation into ‘vulnerability and capacity’ is thus advancing rapidly among those focussed on disaster reduction e.g. the IFRC (Comfort, *et al.*, 1999; Wisner, 2001). Attempts are being made to integrate the various activities of a range of actors at different scales across the phases of the disaster management cycle (e.g. Table 2, Wisner, 2001).

Other recent initiatives in the development of draft indicators include those of UNDP and others involved in disaster risk reduction (UNDP, 2001). These include the identification and role of political commitment and institutional structures (e.g. decentralisation of disaster risk reduction, development and adoption of national plans for risk reduction); knowledge of disaster risk and mitigation (e.g. dissemination and availability of risk and mitigation information); level of structural mitigation (e.g. land use planning, risk adapted codes, norms and standards and hazard prevention measures); risk transfer and social protection – safety nets (e.g. insurance and reinsurance, existence of safety funds, calamity funds etc); level of preparedness (e.g. early warning systems) and finally the political and economic social context (e.g. good governance to insure effective disaster and risk management) of disasters (e.g. Table 3).

### *Humanitarian perspectives – ‘mapping vulnerability’*

Allied to those working in the disaster management are those working in the humanitarian arena. Over the years a number of organised systems of humanitarianism efforts have focussed on aspects of vulnerability. These efforts are driven by various local NGOs and international organisations (e.g. Save the Children Fund; World Food Programme). From

these efforts specific attempts at measures and ways to map vulnerability have been produced.

Some examples, illustrating vulnerability assessment originating from a humanitarian perspective, are outlined below. The aim of several of these case studies is usually on improving food security in the region. In the case of Mozambique, for example, a classification of the country into different food production systems has been a clear requirement of the vulnerability analysis mapping project (VAM). A multidisciplinary group (e.g. Ministries of Health, Department of Nutrition); Ministry of Planning and Finance (Department of Social Development, Poverty Alleviation Unit); National Early Warning Unit within the Department of Agriculture) have been mapping and undertaking the vulnerability analysis in the country (e.g. Diriba, 1997; Grupo inter-sectorial de Avaliao e Mapeamento da Vulnerabilidade, 2000). Some of the preliminary mapping products include flood risk maps; NDVI identification of drought risk areas etc; food systems maps, land use maps, market access maps; and health and nutritional profiles that have been developed (in the latter case, approximately 80 districts out of 128 have been surveyed). One of the exciting aspects to emerge from this work is that collection, analysis and presentation of food security and nutrition has been supported by government and is used as a tool for local development, service delivery and monitoring and is therefore not only seen as 'scientific enquiry'.

Other similar efforts to estimate and prepare for global change have also focused on vulnerability usually (e.g. Eilerts and Vhurumuku, 1997; Eldridge, 1997; WFP and SADC, 1997; SADC and FANR, 2000) in an attempt to identify and understand why populations are food insecure. A recent High Level Vulnerability Assessment Technical Consultation meeting, for example, was recently held in Zimbabwe to discuss vulnerability assessment in the context of food security monitoring and assessment in the region. Methods to determine vulnerability included indicators (e.g. food stats, NDVI etc) and household surveys (e.g. using a food economy approach, including issues of access to food in 'normal' years). A range of VAM techniques were presented including several country presentations from the region. Issues emerging from the meeting around vulnerability included improved institutional and greater coordination of efforts in the region, awareness building and advocacy particularly directed at senior government officials and harmonisation of vulnerability assessment methods (SADC and FANR, 2000).

## *Climate Change and Vulnerability*

Finally, a few studies have begun to apply vulnerability indices to climate change (Downing, 2001). Most of the assessments have involved trying to understand and describe what has and is 'driving and causing' vulnerability ( e.g. a bottom-up approach) and shaping criticality at a certain level. With this as a base, climate change risk is then superimposed onto the 'vulnerability assessment'. At an international level, however, and for purposes of comparison, a 'top-down' approach is also being pursued whereby one seeks to capture the hierarchy of development from the national to local level using various indicators. Attempts at multi-level indicators of vulnerability to climate variability and change have been attempted (see for example, Moss *et al.*, 1999; Huq *et al.*, 1999; Hurd *et al.*, 2000). Linked to, but not focussing exclusively on climate change, is also the syndrome's approach work undertaken by those at the Potsdam Institute for Climate Impacts Assessment (Schellnhuber *et al.*, 1997).

### **Conclusion**

As is evident from the aforementioned examples and discussion, several detailed vulnerability assessments, development of indicators of vulnerability, mitigation assessments and action, have either been completed or are currently being undertaken in various parts of the world. These activities and research initiatives are usually multi-disciplinary in nature and are beginning to provide a clearer picture of vulnerability to global change. Despite these various initiatives, it would appear that some scientists engaged in global change, have often reluctantly interacted with others working on vulnerability assessment. This could be attributed to the 'fuzzy' nature of what exactly is meant by vulnerability and trying to grasp what it is that one is supposed to be measuring: Vulnerability to what? vulnerability for whom? etc. Notwithstanding these problems, it would seem that there is a growing demand and call for improved vulnerability assessments. What then are the implications of such partnerships and developments for global change science?

Outlined below are some observations and suggestions:

- Measures used to grasp vulnerability should not be static but should allow for change over time with a focus (but not sole) on current vulnerability (e.g. how do normal conditions, structural processes, climate etc shape current vulnerability).
- A more nuanced understanding of vulnerability is required including vulnerability assessment across spatial and varying temporal scales e.g. assessing 'present vulnerability at varying scales (e.g. local to household level as well as national assessments) using for example the Human Development Index or other indicators and mapping of vulnerability.
- Greater emphasis and research on the 'double-sided structure of vulnerability' e.g. on adaptive capacity and measures to improve these, as well as on identifying vulnerability need to be encouraged. Ongoing efforts to understand and describe multi-scale, long-term processes of vulnerability, including adaptation and resilience, need to be actively pursued.
- 'Virtual reality' needs to be informed by 'real cases', environmental change assessments need to 'ground truthed'.
- Greater interaction between scientists engaged on vulnerability e.g. global change scientists such as those already engaged in IHDP as well as others working from a hazards or disaster management perspective is needed to establish who is doing research on vulnerability, from what perspective, what issues and lessons are emerging so that we can begin to answer the types of questions outlined above: e.g. vulnerability to what and a host of other questions?
- Scientists also need to begin engaging with other practitioners in the field such as development workers, health workers etc so that an informed assessment of vulnerability can be undertaken.
- Vulnerability assessment cannot be an optional extra to global change initiatives. Vulnerability is not a residual of climate change. Climate change is only one 'driver of change', perhaps a key driver, but still only one of a host of factors contributing to the vulnerability of the environment and communities in the face of global change.
- Finally, vulnerability science requires that concerted efforts to reduce risks and enhance capacity are made. Such efforts cannot only be academic activities removed from the policy arena and from the daily realities of 'vulnerability' in which many find themselves. The need for information exchanges, capacity building through training activities and resource transfers and overall enabling actions need to be undertaken. People need to be enabled to manage their own environments through access to global structures and networks that support 'informed responsible, systematic actions to improve local conditions in vulnerable regions' (Comfort et al., 1999, 43).

Addressing vulnerabilities within the global change context will take time, for it is usually the underlying circumstances in a situation and/or crisis that determines vulnerability and in several cases these conditions and interactions are only beginning to be understood. Therefore it is essential that a constant commitment be made to achieving rigour in vulnerability assessments, paying particular attention to such issues as context, history, capacities, baseline or normal conditions/circumstances, training needs and community involvement. Global change scientists should engage with other practitioners and find ways (if they have not already done so) of ensuring that such work is translated into useful policy. Information should also be translated back to those 'vulnerable' communities and groups so that they can actively engage in future monitoring, and other activities, thereby improving their livelihoods and ensuring resilience and adaptability to global change.

Much remains to be done. As illustrated in this brief overview paper, the activities of a variety of practitioners and scientists engaged in vulnerability research and activities, are, however, beginning to move the 'science' of 'vulnerability' slowly from a 'pot pourri' of terms to the centre stage in global change.

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## **TABLES:**

Please note that a power point presentation is being prepared that will include some of these tables as well as other figures for illustration.

Table 1. Selected variables used in vulnerability assessments and a sample of proposed variables for characterizing dynamic vulnerability (adapted from Ramachandran and Eastman, 1997).

<b>Traditional Indicators of Vulnerability</b>
Share of drought resistant crops
Agroclimatic zones
Average NDVI for last three seasons
Rainfall index
Frequency of drought by watershed
Percentage crop area
Variability of agricultural production
Access to infrastructure
Average cash income
Population density
Infant mortality index
Female literacy rate
Average cost to travel to district market
Civil insecurity
<b>Indicators of Dynamic Vulnerability</b>
Change of access or levels of investment in transportation and other infrastructure
Change in availability of marketing facilities
Change in access to credit
Change in crop subsidy prices
Change in national trade or investment policy
Change in levels or shares of international trade or investment
Change in national or regional industrial structure
Change in soil fertility
Change in climate
Large-scale international movement of people
Changes in rates of HIV/AIDS among households
Escalation of civil war or other military conflict

Table 2: Possible Indicators of Vulnerability/Resilience by Phase of the Disaster Management Cycle and Social Actor e.g. in this case government (adapted from Wisner, 2001).

<b>Prevention</b>	<b>Preparedness</b>	<b>Response</b>	<b>Recovery</b>
Plan Inter-departmental coordination Resources allocated Society-wide partnerships Evaluations	Plan Warning system Stockpiles Training Exercises	Plan Co-ordination Communication and info systems Adequate health care Mutual aid	Plan Resources allocated Structural Non-structural Betterment/mitigation part of recovery

Table 3: Extracts from a draft set of indicators for measuring mitigation efforts (first proposal (adapted from UNDP, 2001).

<b>Theme</b>	<b>Draft indicators</b>	<b>Relevance to each hazard</b>
<i>Level of structural mitigation</i>		
Protection and management of natural resources	a) Implementation of water management measures: Conservation and increase of water reserves, water demand reduction, recycling and distribution Dams, renaturalisation of riverbanks and river beds, flooding b) % major protected areas of national territory c) Trends in deforestation rate	Drought  Flood  Flood  Flood, Drought Volcano

