Eckart Ehlers
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Earth System Science in the Anthropocene

2.2 Assessing Human Vulnerability to Global Climatic Change

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Introduction

Concerns about global climatic change have shifted substantially over the past two decades. Scientific evidence has confirmed human activities have altered the earth's atmosphere to such an extent that wide scale climatic changes are anticipated. One of the consequences stemming from these scientific advances has been a growth in concerns related to the societal consequences of climatic change. This paper traces the development of climatic change – society research and argues there is an urgent need to re-orient this research field in order to incorporate assessments of human vulnerability.

Two generations of Climate Change Assessments

First generation of Assessments: Impact of Climatic Change

Much of the early research into climatic change – societal relationships has been based upon the "impacts" research framework illustrated in Figure 2.2.1. For the purposes of this paper, agricultural examples are employed to assist with explaining the impacts framework but the basic approach has been applied to several other economic sectors and human activities.

Impact studies usually commence with the specification of several climatic change scenarios. While there is little doubt that human activities are and will continue to alter climate systems on a global scale, considerable uncertainty remains about the pace and magnitude of climatic change. Scenarios are regularly deployed to capture this uncertainty and many impact studies will employ "best and worst case" scenarios. Climatic change scenarios are often derived from the

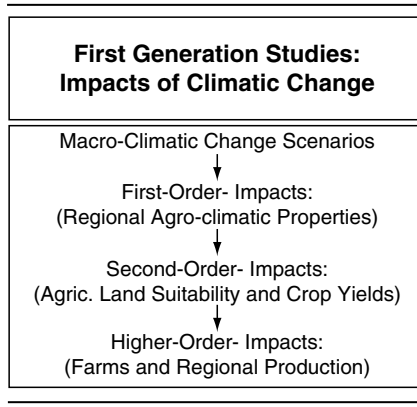

Fig. 2.2.1 First Generation Studies: Impacts of Climatic Change

outputs of General Circulation Models (GCMs) but spatial and historical analogues have also been used to develop scenarios for future climates. The art and science of developing comprehensive scenarios has been developing rapidly and most contemporary scenarios for climatic change are founded upon sets of assumptions regarding long-term prospects for economic development, governance, population and demography and so on.

These climatic change estimates are usually provided at a scale which are too broad for impact assessments and hence the second step involves interpolating these macro scenarios for climatic change into regional climatic change scenarios. These first-order impacts involve down-sizing the scale of the macro-climatic change scenarios as well as converting basic climate data such as change in mean daytime temperature and daily precipitation into parameters that are useful within the context of the specific study. For example, basic climate data would be converted into the start and end of the frost-free season for climatic change – agricultural impact studies.

Second-order impacts typically estimate the impacts of climatic change on primary economic activities. For climatic change – agricultural studies, agricultural land suitability and crop yield models have been used extensively to estimate the potential effects of estimated changes to climate on where particular crops might be grown and on crop yields. Higher-order impacts typically employ the outputs of second-order assessments to gauge the effects of climate change on agricultural production and profitability at farm through regional levels.

Second generation of Assessments: Responses to Climatic Change

Second generation assessments recognised that socio-economic systems are dynamic and regularly respond to external stimuli. Second generation assessments

employ the same basic research framework as first generations assessments but extend the analyses to include responses to impacts emanating from global climatic change (Figure 2.2.2). Overall, second generation studies add feedback loops to the impacts research framework and responses can be put into three broad categories: non-response, mitigation and adaptation. In all cases, the human activities associated with the various responses can alter future climatic changes.

These second generation studies acknowledge that impacts will not always prompt a response and hence the inclusion of the non-response category. Non-response could occur for several reasons including impacts not representing a threat to the socio-economic sector in question, there being no known technology to overcome negative impacts, and economic, political and technological constraints preventing a response (e.g. lack of knowledge of response options, insufficient capital to adapt, weak institutions diminish the likelihood of a response).

The mitigation and adaptation options incorporate changes in human behaviour as well as climate however the basic tenants underpinning these two response options are fundamentally different. Mitigation assessments are based upon preventing, or at least reducing the pace and rate of global climatic change. Mitigation options can include approaches which would reduce greenhouse gas emission levels at the source (i.e. improving fuel-use efficiency and conversion to alternative energy sources which are not reliant on fossil fuels) as well as carbon sequestering which assists with reducing atmospheric CO_2 levels (e.g. reforestation and rebuilding of soil carbon stocks).

This preventative approach is contrasted by adaptation which investigates how changes in human behaviour could either offset negative impacts stemming from climatic change or, in the case of positive impacts, allow an economic sector to capitalise on these new opportunities. In other words, it is assumed that climatic change has and will continue to occur and the primary driving force behind this response option involves investigating and implementing adjustment strategies.

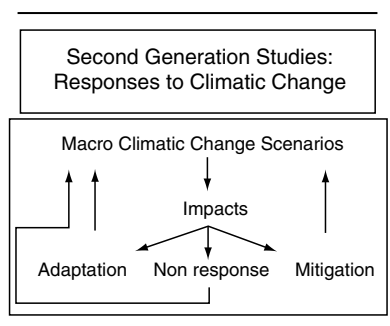

Fig. 2.2.2 Second Generation Studies: Responses to Climatic Change

Attributes of first and second generation Assessments

Several attributes are common to both first and second generation climatic change assessments. Some of their key attributes include, the assessments:

- are relative to a single external stimuli (i.e. climatic change)
- assume climatic change will occur slowly and incrementally,
- are conducted at one spatial scale and do not consider cross-scale impacts,
- are triggered by climatic change and therefore there is only limited consideration of socio-political context in which climatic change occurs, and
- consider human vulnerability as a residual of climatic change impacts.

The cumulative effect of these common attributes is that the first and second generation assessments are well-suited to isolating the effects of single stressors (e.g. impact of climatic change on crop yields) and on a single sector (e.g. agriculture, forestry) as well as gauging the technical efficiency of a specified response option (e.g. effectiveness of irrigation and/or alternative cultivars as a means to offset crop yield reductions stemming from drier climates). Recent advances in estimating climatic change at various spatial scales, improvements in impact assessment methods and a more thorough understanding of response options continue to improve the accuracy of assessments based upon these first two generations of climatic change assessments. Nevertheless, there is a growing demand to broaden the basis for climatic change assessments and to explicitly engage with the concepts relating to risk and vulnerability. The first two generations of climate change research were however never designed to treat societal concerns in a holistic fashion and are not well-equipped to explicitly consider human vulnerability to climatic change.

Towards a third generation Climatic Change Assessments: A Human Vulnerability Focus

Foundations of Human Vulnerability Concepts

Even though few climatic change studies have explicitly assessed human vulnerability, it is not a new concept. For example, natural hazards research usually defines vulnerability as the potential for loss and distinguishes between biophysical and social vulnerability (Cutter 1996). Biophysical or inherent vulnerability is associated with the attributes or characteristics (e.g. magnitude, duration, frequency) associated with a naturally occurring event such as an earthquake, flood or cyclone. The impacts on human activities and human well-being of natural phenomena are very seldom uniform as the event is mediated through a range of social, economic and political conditions. Hazards research recognises impacts on human activities are a function of both the events characteristics and broader societal con-

ditions, and hence the study and assessment of natural hazards focuses on the interaction between natural events and human systems and not the natural system in isolation (Mustafa 1998).

Early work into the mitigation of human impacts stemming from natural hazards usually focused on the natural phenomena and concentrated on technocratic and engineering solutions such as levees to reduce flood risk and irrigation systems to reduce drought risks. This sort of solutions has without doubt decreased human injury and loss of life. This reliance on technology has, however, been criticised for at least two reasons. First, they often encourage intensive human development in hazard prone areas which can lead to massive losses in investment and human lives when the engineering measure fails. Floods in the Mississippi and Saguenay River Valleys in the USA and Canada respectively during the 1990s serve as vivid examples of the consequences of an over reliance on engineering approaches which also shifts the focus away from the underlying social-economic-political factors that play crucial roles in determining the human impacts of extreme events. Another concern is that the high capital cost associated with implementing engineering solutions is often beyond the economic grasp of poorer countries and communities. Concerns about the equity of many engineering solutions have been raised and their tendency to reinforce divides between "have" and "have-not" regions has also been brought into question.

Behavioralist approaches have expanded the field of hazards research beyond technocratic and engineering perspectives to include approaches which address questions relating to how individuals and institutions perceive hazards (Burton et al. 1993) as well as approaches which explicitly focus on the social and political causality of human vulnerability to hazards (Blaikie et al. 1994, Watts and Bohle 1993, Davis 2001). This latter approach has led to the development of comprehensive notions of human vulnerability to hazards and related phenomena such as hunger and famine. In this broadened context, vulnerability is not viewed as a result of an extreme event but rather as a societal characteristic or property which is present in a social system prior to the onset of the extreme event. Earlier work by Watts and Bohle (1993) explored the social space of vulnerability and revealed how famine was attenuated by access to resources, power relations and class relations. In this context, human vulnerability was developed as a three-dimensional concept which focuses attention explicitly on the underlying socio-political causes which triggered famine rather than studying an extreme natural phenomena such as a seasonal drought. Benefits stemming from this approach include insight into how human vulnerability varies amongst subpopulations within a region as well as an improved understanding of whether the primary cause of a famine is attributable to inadequate access to agricultural resources such as land and water or weak institutions or concentration of power or some combination of these factors. This basic approach has been developed further and applied to several environmental hazards (Adger 1999, Cutter 2000, Mustafa 1998) and most recently to non-conventional threats to human security (Watts 2002).

Moving from Hazards to Climate Change

Natural hazards and famine-related research typically consider relatively narrow time frames over which societal changes would be minimal and therefore it is legitimate to assume societal change as exogenous to specific case studies. Climatic change is however expected to occur over a longer period and hence it is inappropriate and misleading to assume stable social systems (Clark 1985, Wilbanks and Kates 2001). This does not suggest that the basic tenets which underpin human vulnerability concepts as developed within a natural hazards context are unworkable in a climatic change context but it does suggest that a dynamic element will need to be added to these essentially static frameworks in order to capture changes in both climate and social systems. For example, economic globalisation has become a set of pervasive forces which are contributing to fundamental and wide sweeping changes in economic, social and political systems. In addition to further concentration of wealth and increase in competition amongst multi-national firms, economic globalisation is challenging and changing relationships between nation-states and the private sector. As a result, the structure and role of both formal and informal institutions are being re-defined which in turn are altering human vulnerability to environmental threats and environmental change. It is in this context that human vulnerability can be magnified by the synergistic effects stemming from a more variable climate as well as the consequences of economic globalisation (O'Brien and Leichenko 2000).

Figure 2.2.3 represents one approach to capturing the combined effects of both climatic and societal change on human vulnerability. This framework defines human vulnerability in the context of exposure to climatic change and the capacity to cope with and recover from climatic change. Exposure is sensitive to both climatic and societal changes. For example, a future climate characterised by more frequent and intense storms would result in greater exposure only if formal and informal institutions which currently insulate society from climatic events were not able to adequately protect society from the expected increases in more severe weather. Overall, assessments of exposure to climatic change need to consider both climatic and societal changes.

Coping and recovery capacity is also cast in the context of climatic and societal change. More frequent storms could contribute to less than full economic recovery between storms and these cumulative effects could stretch the coping capacity of a particular community beyond its current limit. From a societal change perspective, a weakened economy could make recovery more difficult and thereby reduce the capacity to cope with the next climatic extreme.

The approach outline in Figure 2.2.3 develops vulnerability as a dynamic concept which is sensitive to both changes in exposure and coping capacity. It does not view vulnerability as a residual of climatic change impact but rather it positions human vulnerability as precursor to impacts. If a community possesses sufficient coping capacity, then it would follow that an altered climate would not necessarily result in economic and social disruptions. Similarly, it may be possible

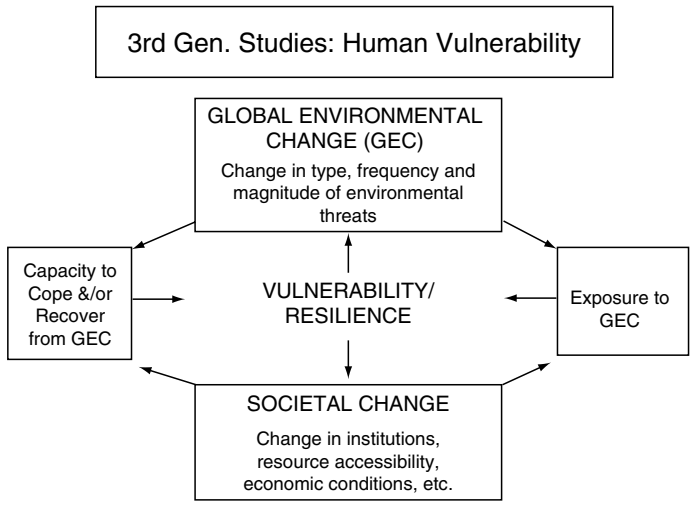

Fig. 2.2.3 Third Generation Studies: Human Vulnerability

to bolster the capacity of a community to cope and thereby offset potential negative impacts associated with climatic change. Overall, the approach provides a foundation for assessing the relative merits of mitigating climatic change compared to bolstering adaptation capacity.

Further Development of Vulnerability Concepts

Much work has been done on the vulnerability topic, but little has so far been developed in terms of concepts and theories that might help to more systematically explore environmental and social vulnerabilities. Figure 2.2.4 is a simplistic first attempt to pull together, by no means exhaustively, some theoretical debates relevant to environmental and social vulnerabilities. The model includes new strands of thinking in social and environmental theory. It builds upon the Environmental Entitlements Program, which has been developed by the Institute of Development Studies in Sussex and has since been taken up by various development agencies, focuses on community-based sustainable development (see e.g. Leach, Mearns and Scoones 1997). The programme focuses upon who regulates access to and command over scarce, contested environmental goods and services, and in this context, vulnerability rises as access to environmental goods and services is impeded. The programme draws upon an array of theoretical considerations, including social theory, environmental theory, entitlements theory and conflict theory. The issue of institutions is also widely discussed, because institutions play a central role in mediating the relationships between environment and society, between land and land managers.

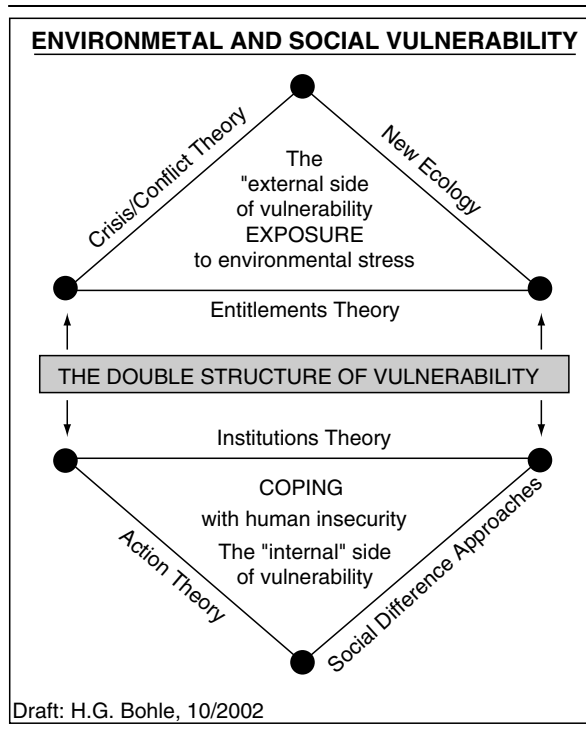

Fig. 2.2.4 Environmental and Social Vulnerability

Figure 2.2.4 emphasises the double structure of vulnerability with the "coping component" focusing on social vulnerability and the "exposure component" concentrating on environmental vulnerability. Social difference theory is taken up to show that gender, caste, wealth, age, origins and other aspects of social identity divide and crosscut community boundaries. This study emphasises how diverse and often conflicting values and resource priorities in degraded environments – rather than shared beliefs and interests – pervade social life and may be struggled and "bargained" over (e.g. Carney and Watts 1997). Equally, social difference theory draws attention to power as a pervasive feature of land management (e.g. Gaventa 1995).

Another strand of social theory, action theory, argues that land managing communities cannot be treated as static, undifferentiated wholes, since they are composed of active people and groups. The behaviour of social actors is not driven automatically and unconsciously by structures of environmental change and land degradation; rather they actively monitor, interpret and shape the environment around them (e.g. Long and Long 1992). Action theory has also grappled with the links between agency and structure, emphasising how structures, rules and norms can emerge (and only exist) as products of people's land use practices and actions, both intended and unintended. These structural forms subsequently shape people's

actions, not by strict determination but by providing flexible orientation points, which either constrain or enable what is possible in community-based sustainable development under conditions of global environmental change (e.g. Long and van der Ploeg 1994).

The so-called "new ecology" approach (e.g. Botkin 1990) stresses that spatial and temporal variability in land degradation which contribute to dynamic, non-equilibrial processes of land use and histories of disturbance events. Just as communities cannot be treated as static or undifferentiated, made up as they are of active land managers, the environment equally needs to be disaggregated into its constituent parts (soil, water, vegetation, rocks, climate, relief), and viewed dynamically.

Entitlements theory (e.g. Sen 1981; for a new critical discussion, see Watts 2002) is employed to explain how the consequences of land degradation and access to and control over land are also socially differentiated. Entitlements refer to legitimate effective command over alternative commodity bundles, i.e. land, water and workforce. More specifically, environmental entitlements refer to alternative sets of utilities derived from environmental goods such as land and water over which social actors have legitimate effective command, the management of which are instrumental in achieving well-being.

Violent conflict, frequently fought along ethnic cleavages, is certainly one of the most dramatic and increasingly widespread threats to human security. From the perspective of conflict theories based on rational choice theory, "ethnic" conflicts have been conceptualised as stemming from "structural antagonisms" which may lead to mobilising "cultural resources". This is why violent conflict can become so highly emotional and extremely violent (Esser 1998). Others view violent conflict also as "structural conflicts", but explain the mobilisation of violence as a reaction to a new "global disorder" (IDS Bulletin 2001). Still another approach has been propagated by Wimmer (2002) who explains widespread violent conflict as an outcome of nationalist exclusion. This process is most acute in the process of nation-building, when groups in a privileged relationship to the modernising state may enjoy democratic participation, equality before the law and self-determination, while minority groups ("ethnic" minorities) are denied these privileges, which frequently leads to brutal civil wars. The key point here is that crises and conflict can destabilise societies and thereby increase exposure to environmental stress.

Last but not least environmental entitlements concepts also draw on institutions theory (North 1990). Institutions play a central role in mediating the relationships between environment and society, between land and agriculturists. Many analysts have described institutions either as "rules" or as "organisations" and more recently, institutions have rather been conceptualised as "rules in action" or "regularised practices". The central question that emerged is asking which combination of institutions makes the most difference to resource access and control for a set of social actors, or for the dynamics of resources use and management surrounding particular valued elements of the landscape. Community-based sustainable development is always shaped by institutions that are embedded in structures of power relations, that are made and remade, and that are highly contested through people's practice.

Conclusion

This paper has traced the development of climatic change studies and argued there is an urgent need to fully incorporate human vulnerability concepts into this research field. The roots of research into human vulnerability to environmental stresses can be traced back to natural hazards research and over the past decade there has been a growing recognition that human vulnerability has both an external component which determines exposure to environmental stress and an internal component which examines human capacity to cope. The development of vulnerability concepts has to a large extent occurred outside the climatic change community. There appears to be a solid foundation better for incorporating human vulnerability within climatic change research and the vulnerability frameworks illustrated in this paper provide a basis for re-orienting climatic change studies. There is however an urgent need to build upon these vulnerability frameworks and develop a set of placed-based research programs to test the strengths of these frameworks within a climatic change setting.

Acknowledgements

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