

# THEORY AND PRACTICE IN ASSESSING VULNERABILITY TO CLIMATE CHANGE AND FACILITATING ADAPTATION

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**Abstract.** We discuss approaches to the assessment of vulnerability to climate variability and change and attempt to clarify the relationship between the concepts of vulnerability and adaptation. In search of a robust, policy-relevant framework, we define vulnerability in terms of the capacity of individuals and social groups to respond to, that is, to cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being. The approach that we develop places the social and economic well-being of society at the centre of the analysis, focussing on the socio-economic and institutional constraints that limit the capacity to respond. From this perspective, the vulnerability or security of any group is determined by resource availability and by the entitlement of individuals and groups to call on these resources. We illustrate the application of this approach through the results of field research in coastal Vietnam, highlighting shifting patterns of vulnerability to tropical storm impacts at the household- and community-level in response to the current process of economic renovation and drawing conclusions concerning means of supporting the adaptive response to climate stress. Four priorities for action are identified that would improve the situation of the most exposed members of many communities: poverty reduction; risk-spreading through income diversification; respecting common property management rights; and promoting collective security. A sustainable response, we argue, must also address the underlying causes of social vulnerability, including the inequitable distribution of resources.

## 1. Introduction

The primary aim of this article is to examine ways of defining vulnerability to environmental stress, specifically, climate variability and change. In the context of the global warming problem, assessing vulnerability is an important component of any attempt to define the magnitude of the threat. Moreover, analysis of vulnerability provides a starting point for the determination of effective means of promoting remedial action to limit impacts by supporting coping strategies and facilitating adaptation. We focus on the vulnerability of human individuals and communities to climate stress. A secondary aim of this article is to clarify the links between vulnerability and adaptation (cf. Burton, 1997). Adaptation is a topic of considerable policy relevance and concern (Smith et al., 1996) but, to date, has not been effectively assessed (Smithers and Smit, 1997; Tol et al., 1998). Climate impact studies have tended to focus on direct physical, chemical or biological effects, yet a



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full assessment of consequences for human well-being clearly requires evaluation of the manner in which society is likely to respond through the deployment of coping strategies and measures which promote recovery and, in the longer-term, adaptation.

We begin our discussion with a review of definitions of vulnerability, drawing on the food security and natural hazards literature as well as previous climate studies. From this review, a working definition of vulnerability is derived that emphasises the social dimension neglected in previous studies and is of direct relevance to the development of policy and practice. We then draw out various implications of this definition and discuss how it might be operationalised. We argue that any analysis of vulnerability must consider the 'architecture of entitlements', the social, economic and institutional factors that influence levels of vulnerability within a community or nation and promote or constrain options for adaptation. Finally, we illustrate this largely theoretical discussion with examples drawn from field research undertaken in northern Vietnam during which the selected approach was developed, tested and refined. As a society undergoing rapid change, Vietnam provides a dynamic test bed of broad relevance illustrating how social, economic and political trends and characteristics shape patterns of vulnerability.

In the case studies, our primary concern is with vulnerability to *short-term* hazards, in particular, tropical cyclone impacts. It is short-term hazards and extreme climate events on the seasonal and interannual timescale that the bulk of any population experiences and reacts to, rather than long-term trends, and it is through the varying character of these events that any long-term change in climate will first be manifest. See the general discussion of this issue by Burton (1997) and the specific examples given by Smit et al. (1996) and Palutikof et al. (1997). How valid is it to extrapolate from these findings to longer timescales? We would argue that the primary linkages between social, economic and political characteristics and trends and the capacity to react to environmental stress that we identify will hold on all timescales, even if the precise response strategies alter in nature or relative significance. Glantz (1991) discusses the strengths and limitations of the use of analogies in forecasting societal responses to climate change.

## 2. Defining the Concept of Vulnerability

Definitions of vulnerability to environmental stress vary considerably. Some analysts regard assessment of vulnerability as the end point of any appraisal, others as the focal point, and yet others as the starting point. And these different views carry considerable baggage regarding, amongst other things, levels of certainty and uncertainty, policy relevance and disciplinary focus.

According to the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (see the Glossary of Terms, Appendix B in Watson et al., 1996), vulnerability defines 'the extent to which climate change may damage or harm a

system; it depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions'. Sensitivity, in this context, is 'the degree to which a system will respond to a change in climatic conditions'. From this perspective, the definition of vulnerability must be contingent on estimates of the potential climate change and adaptive responses. The assessment of vulnerability is the *end point* of a sequence of analyses beginning with projections of future emissions trends, moving on to the development of climate scenarios, thence to biophysical impact studies and the identification of adaptive options. At the final stage, any residual consequences define levels of vulnerability; that is, the level of vulnerability is determined by the adverse consequences that remain *after* the process of adaptation has taken place and, as such, it provides a convenient means of summarising the net impact of the climate problem, a major goal of the IPCC process. In the context of coastal studies, Klein and Nicholls (1999) discuss a variant of the IPCC approach endorsed by the United Nations Environment Programme.

A contrasting use of the concept of vulnerability is found in the food insecurity, or famine, and natural hazards literature as well as some climate studies (e.g., Downing, 1991; Watts and Bohle, 1993; Bohle et al., 1994; Blaikie et al., 1994; Cutter, 1996; Ribot et al., 1996; as reviewed by Adger, 1996). Watts and Bohle (1993), for example, argue that the space of vulnerability to food insecurity can be defined in terms of the exposure to stress and crises, the capacity to cope with stress, and the consequences of stress and the related risk of slow recovery. Essentially, they consider vulnerability an overarching concept, a *focal point*. From a natural hazards perspective, Blaikie et al. (1994) define risk as consisting of two components. The first component, equivalent to Watts and Bohle's exposure, is a measure of the natural hazard. The second, vulnerability itself, is equivalent to capacity and is, they argue, largely determined by socio-economic structure and property relations.

Blaikie et al. (1994) clearly separate what we may term the biophysical and the social dimensions, defining vulnerability in terms of the human dimension alone as 'the capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard'. The biophysical component, the exposure or measure of the hazard, is formally outside their definition of the concept of vulnerability. Having said that, it is intrinsic to the definition that vulnerability must always be linked to a specific hazard or set of hazards, so vulnerability and exposure remain inseparable. The concept of vulnerability, in this instance, provides a policy-relevant framework within which the value of specific interventions aimed at improving the capacity of people to respond to stress can be judged. By identifying likely sensitivities in terms of a limited capacity to respond to stress, it represents a potential *starting point* for any impact analysis. As far as the relationship between vulnerability and adaptation is concerned, vulnerability is defined in terms of the capacity to adapt and vulnerability assessment, in this case, is not dependent on predictions of adaptive behaviour.

If we trace the linguistic roots of the word vulnerability then we find support for the conceptualisation adopted by Blaikie et al. (1994). The Collins English Dictionary (Second Edition, 1986) defines vulnerability as, *inter alia*, the 'capacity to be physically or emotionally wounded or hurt'. The origin of this word lies in the Latin *vulnus*, meaning 'a wound', and *vulnerare*, 'to wound'. Specifically, the word vulnerable derives from the Late Latin *vulnerabilis*, and this is enlightening. *Vulnerabilis* was the term used by the Romans to describe the state of a soldier lying wounded on the battlefield, i.e., already injured therefore at risk from further attack. The relevance to the present discussion is that vulnerability, in this classic sense, is defined primarily by the prior damage (the existing wound) and not by the future stress (any further attack). By analogy, then, the vulnerability of any individual or social grouping to some particular form of natural hazard is determined primarily by their existent state, that is, by their capacity to respond to that hazard, rather than by what may or may not happen in the future.

In the research reported here, we adopt a definition closely allied to that advanced by Blaikie et al. (1994). Thus, we define vulnerability in terms of the ability or inability of individuals and social groupings to respond to, in the sense of cope with, recover from or adapt to, any external stress\* placed on their livelihoods and well-being. Implicit in this definition of vulnerability is the adoption of the 'wounded soldier' perspective in focussing attention on constraints, 'wounds', that limit the capacity to respond to stress effectively and that exist independent of the future threat. We use the term 'social vulnerability' to underline the emphasis of this approach on the human dimension, rather neglected in past studies of vulnerability and adaptation (Adger and Kelly, 1999).

The nature of the stress under consideration must, of course, be specified before tackling the question of levels of vulnerability when following this approach. Vulnerability does not exist in isolation, only with respect to exposure to some specific impact or set of impacts. Here, the analysis of the nature of the stress, the exposure, sets the context for the study, defining the domain or scope of the research and critical issues for analysis, as illustrated in a later section. Given the focus on pre-existing constraints on the capacity to respond, it is not, however, necessary to define precisely the nature of the potential impact, nor the likely course of the adaptive process, as it would be if vulnerability were defined, as in most climate impacts studies, in terms of the residual consequences once adaptation had occurred.

\* The phrase 'external stress' is used to refer to stress that it is not within the power of the individual or social grouping to avert completely at source (by, for example, substantially reducing global greenhouse gas emissions in the case of climate change). The word 'stress', with its connotation of adverse impacts, is used deliberately. Some consequences of climate change may well prove beneficial in the long run but, without a considerable degree of prescience so that adaptive strategies can be deployed in anticipation of trends, the initial impact of any change in the environment will inevitably be stressful as existing practices are rendered less effective.

We select this particular approach to the issue of vulnerability because we are concerned with identifying robust, policy-relevant recommendations and conclusions regarding vulnerability to long-term climate change that are also relevant to immediate needs and, hence, consistent with a precautionary approach to the climate problem (Kelly et al., 1994; Kelly, 2000). The 'wounded soldier' approach concentrates attention on the socio-economic and political context within which the impact process takes place, a context that may well determine vulnerability not only to climate stress but also to other forms of environmental and societal pressure. Study of vulnerability to climate stress in this fashion should, then, throw light on the broader issue of sustainability, an immediate and lasting concern. Robustness stems from the shift of focus away from the speculative future. Consider the pyramid of uncertainty that we build whenever we attempt to predict the future. Our definition of vulnerability rests the superstructure of the pyramid, implications for policy, on the relatively sound foundation of the analysis of processes that limit or favour the ability to respond to stress and means by which they can be offset or reinforced (Glantz, 1991), rather than on less certain projections of impacts and adaptive responses.

It would be foolish to suggest that any particular approach to the concept of vulnerability is more or less appropriate in the context of climate impact studies. The purpose of the analysis must guide the selection of the most effective definition or conceptualisation. We wish to define the social construction of vulnerability – how different socio-economic and political characteristics, processes or trends influence levels of vulnerability – and, hence, develop policy practice that might improve future prospects. The IPCC is more concerned, at this stage of the climate debate, with assessing the overall scale of the global warming problem and providing comparative estimates. The critical point is that the result of that selection should be made explicit, as must the basis of the decision-making (cf. Schneider (1997) with regard to the related area of integrated assessment modelling). Transparency in defining terms is important not only because, in its absence, confusion can arise in comparing the conclusions of different studies but, in dealing with vulnerability from a societal perspective, the issue of values comes to the fore. Aspirations for the future, for example, can affect perceptions of vulnerability, and the subjectivity, the values, of the analyst may skew recommendations regarding priorities for intervention. As discussed later, the inherently political nature of issues such as property rights that affect levels of vulnerability cannot be ignored. Arguably, it has been the impossibility of engaging with the more political aspects of the issue of vulnerability that has led the Intergovernmental Panel on Climate Change, operating as it must within a framework of consensus decision-making, to focus on biophysical aspects of the subject. Analysing biophysical impacts is not, of course, a value-free activity, but problematic areas may not be as obvious.

### 3. Operationalising the Definition of Vulnerability

We base our examination of social vulnerability to climate variability on an understanding of the human use of resources. Following Sen (1981, 1990), the extent to which individuals, groups or communities are 'entitled' to make use of resources determines the ability of that particular population to cope with or adapt to stress. The concept of entitlements, which extends beyond income and other material measures of well-being, has been used in a variety of contexts (cf. Sen, 1990; Watts and Bohle, 1993; Bohle et al., 1994; Cutter, 1996; Hewitt, 1997). Determining levels of vulnerability to climate stress involves defining what we term the 'architecture of entitlements' (Adger and Kelly, 1999), the myriad factors that shape the availability of entitlements, their evolution over time, and the broader political economy of the formation and distribution of entitlements. In considering the factors that shape vulnerability, it is convenient to distinguish between individual vulnerability and collective vulnerability (Adger, 1999a), though these aspects are, of course, intrinsically linked through the political economy of markets and institutions.

Table I illustrates how particular characteristics of an individual, household or community affect entitlements and, hence, vulnerability. These are, of course, not the only factors that influence levels of vulnerability but they are central to the processes we have observed in our case studies in Vietnam. Poverty is related directly to access to resources and the process of marginalisation, though wealth is not in itself a guarantor of security as resources are mediated through property rights and so on. We consider that increasing inequality within a population can heighten collective vulnerability, all other things being equal. Greater inequality may be associated with a reduction in communal resource allocation and in the pooling of risk and other social phenomena associated with the so-called moral economy (Scott, 1976). In addition, there are strong links between inequality and a lack of diversification of income sources as well as with poverty, placing further constraints on response options (Reardon and Taylor, 1996). The final indicator of vulnerability is what we might term the institutional context. Here, the term 'institutions' covers not only formal political structures but also the more diffuse 'rules of the game' and social and cultural norms. Poverty, the use of resources, and the distribution of wealth and income within a population, factors that shape vulnerability, are all in turn institutionally determined. Formal political institutions devise and implement the legal enforcement of property rights, for example, and all economic structures can be viewed as dependent on the institutional structure that frames them. O'Riordan and Jordan (1999) argue that, alongside holding society together, a primary role of institutions is, in fact, to enable society to adapt. Assessment of vulnerability, then, requires analysis of the political economy and examination of the structures of institutions, constraints on institutional adaptation and evolution and the constraints institutions exert on individuals (Sanderson, 1994).

TABLE I

Selected characteristics of vulnerability and their assessment (from Adger and Kelly, 1999)

Vulnerability indicator	Proxy for:	Mechanism for translation into vulnerability
Poverty	Marginalisation	Narrowing of coping and resistance strategies; less diversified and restricted entitlements; lack of empowerment
Inequality	Degree of collective responsibility, informal and formal insurance and underlying social welfare function	<i>Direct:</i> concentration of available resources in smaller population affecting collective entitlements <i>Indirect:</i> inequality to poverty links as a cause of entitlement concentration
Institutional adaptation	Architecture of entitlements determines resilience; institutions as conduits for collective perceptions of vulnerability; endogenous political institutions constrain or enable adaptation	Responsiveness, evolution and adaptability of all institutional structures

While we can quantify, more or less accurately, many of the factors that influence levels of vulnerability, such as poverty and inequality, we do not consider it appropriate to take this analysis a stage further and attempt to devise a composite index of vulnerability itself. First, we cannot be confident that all the processes that determine vulnerability can be reliably identified on the basis of current understanding. Second, there is a danger that those factors that can be easily incorporated in a composite index, such as poverty, will be over-emphasised as factors such as institutional adaptation that, although no less important, cannot be as readily quantified are neglected. Finally, the links between the factors that may influence vulnerability and the overall level of vulnerability in a community are not well-established, making it difficult to weight the various factors and, indeed, as we shall see, to determine the sign of the net effect in some cases. This is not to say that the quantification of vulnerability to draw, for example, contrasts between nations

should not be attempted, but that other approaches to defining vulnerability may be more appropriate if comparison is the goal of the exercise.

#### 4. Analysing Social Vulnerability

##### 4.1. INTRODUCTION

To illustrate the operationalisation of the concept of vulnerability developed here and to draw out key conclusions regarding factors which influence levels of vulnerability and the adaptive process, we present selected results from case study research in northern Vietnam. This work was largely conducted through household-level surveys and interviews with key informants, allied to analysis of present and potential climate regimes to define exposure. The focus was vulnerability to tropical storm impacts in coastal areas of the Red River Delta and the adjacent region. We begin this account with a summary of the physical dimension of the risk faced by the population of these areas: the exposure to present-day and future cyclone landings. This assessment provides a context for the ensuing analysis of social vulnerability, revealing which people are at risk, defining the key characteristics of the threat and identifying geophysical constraints on response options.

##### 4.2. EXPOSURE TO CYCLONE IMPACTS

The landing of a tropical cyclone or typhoon presents one of the major physical threats to the well-being of the inhabitants of the 3000-km coastline of Vietnam (Kelly et al., 2001). Despite a well-developed, albeit under-resourced, storm protection system (Benson, 1997), a single storm can have devastating consequences with most damage occurring as a result of the associated surge, heavy rainfall and wind.

Southern Vietnam was, for example, hit by Severe Tropical Storm Linda during the first two days of November 1997. The rapid development of the storm in the East Sea (South China Sea) not far from the Vietnamese coast meant that little warning could be given to the thousands of fishermen who were at sea as the storm approached. The fishing fleets are made up of boats powered by small 15 to 20 hp engines. Very few of the fishermen have radios and even less carry life preservers. Many had, it is said, set out to sea to take advantage of the abundant fishing as the storm's leading edge brought nutrients closer to the surface. Following the typhoon's passing, helicopters and navy cutters were used in a massive search and rescue operation with the result that around 5000 fishermen were rescued, after clinging to buoys or boat planks, even empty plastic bottles, some for days. Meanwhile, on land, entire communities were flattened, tens of thousands of people were left homeless, 22 000 hectares of rice-fields were destroyed, and roads, dykes and bridges were smashed and washed away. The overall cost of the damage ap-



proached US\$600 million. Known fatalities stand at 778 people as of July 2000, but 2132 individuals remain unaccounted for.

Tropical Storm Linda was unusual, reportedly the most powerful storm to strike the extreme south since 1904. But the risk of storm landing is considerable throughout Vietnam. The nation lies at the end of one of the most vigorous cyclone tracks in the world, with the storm season lasting from May through to December (though storms can strike throughout the year). No sector of the coastline can be considered 'cyclone-free', and this represents a geographical constraint on response options. Figure 1 shows the record of storm incidence over the period 1900 to 1995. The year-to-year variability is great, with typhoon approaches ranging from one a year to as many as 12 a year in recent decades. These figures mask the geographical variation that also occurs, with any particular stretch of coastline experiencing a far greater variability from year to year in strike rates. The storm season of 1992 provides a graphic example of the exposure of one of our case study sites in Quang Ninh Province in northern Vietnam, with two storms passing over in just over two weeks (Figure 2). Recurrent strikes, of course, seriously limit to the capacity to recover from each individual event, with consequences accumulating in a non-linear fashion. We are concerned, then, not only with individual events but also with the cumulative impacts occurring during seasons when cyclone numbers are high.

The El Niño Southern Oscillation (ENSO) phenomenon is a major cause of this year-to-year variability in the number of cyclones approaching the Vietnamese coastline (Li, 1987; Chongyin, 1988; Nishimori and Yoshino, 1990; Lander, 1994; McGregor, 1994; Saunders et al., 2000; and Kelly et al., 2001). Numbers are higher during La Niña events, during cold episodes, particularly late in the season over southern Vietnam (Figure 3). The Vietnamese Hydrometeorological Service is exploring the development of a predictive capability based on the ENSO phenomenon (Tran Viet Lien, personal communication, 7 November 1999). This is a good example of a win-win strategy, strengthening current capacity to resist short-term climate extremes and the ability to respond to any longer-term trend. There is no firm evidence, though, of any long-term trend at present. The drop in frequency from the mid-1970s to the mid-1980s is considered to be largely a result of a reduction in the number of relatively short-lived storms in the East Sea (South China Sea) and reflects the adverse effect on reporting of the end of the Vietnam war and the subsequent embargo. Apparent trends in earlier periods are also quite likely to be the result of variable reporting rates.

What of the future? There is concern that global warming might affect tropical cyclone characteristics, number or intensity, because sea surface temperature plays an important role in determining whether or not tropical disturbances form and intensify. See Bengtsson et al. (1996), Sugi et al. (1996) and Knutson et al. (1998) for recent modelling studies of the possible effect of global warming on tropical storms in the western Pacific sector and Nakagawa et al. (1998) and Walsh and Pittock (1998) for current overviews.

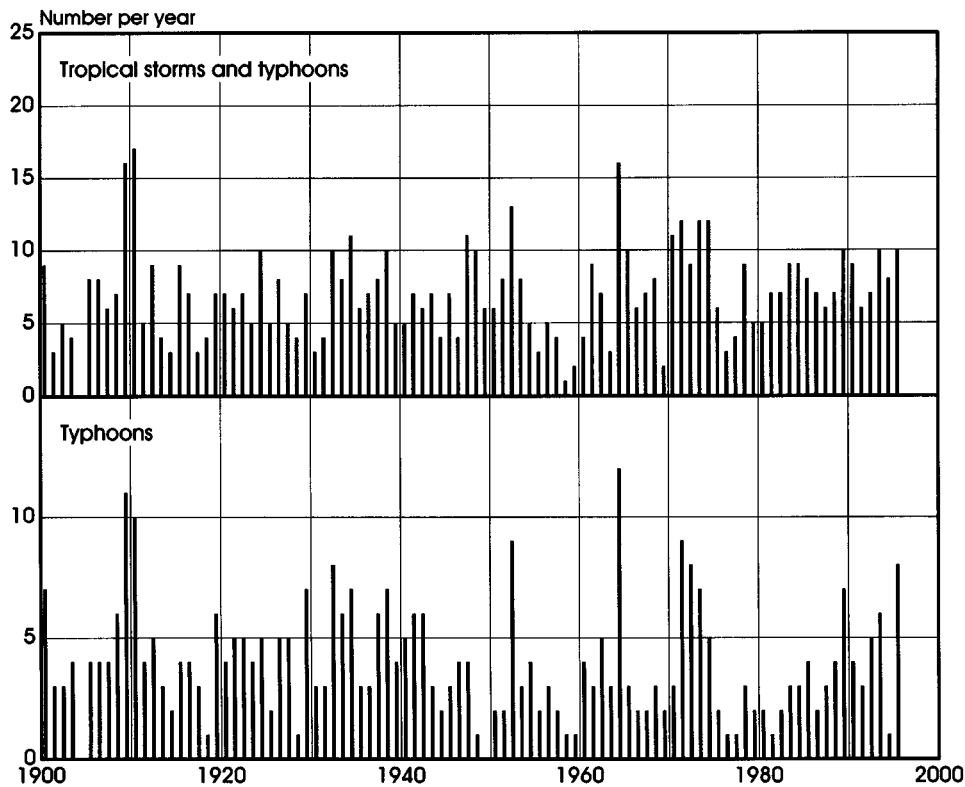


Figure 1. The number of tropical storms (wind speed greater than  $16 \text{ ms}^{-1}$ ) and typhoons (wind speed greater than  $33 \text{ ms}^{-1}$ ) approaching the coastline of Vietnam (specifically, entering the latitude/longitude box  $7.5\text{--}22.5^\circ \text{ N}$  and  $105.0\text{--}115.0^\circ \text{ E}$ ). The cyclone data depicted in Figures 1–3 are drawn from the CD-ROM, *Global Tropical/Extratropical Cyclone Climatic Atlas Version 2.0* (U.S. Navy-Department of Commerce, Washington, D.C., 1996).

How much confidence can we have in these projections? The IPCC First Assessment Report concluded that ‘there is some evidence from model simulations and empirical considerations that the frequency per year, intensity and area of occurrence of tropical disturbances may increase. . .’ but qualified this rather tentative statement with the rider that the evidence is ‘not yet compelling’ (Houghton et al., 1990). Reviewing current understanding some years later, Lighthill et al. (1994) concluded that there is no reason to expect any overall change in global tropical cyclone frequencies though substantial regional changes may occur. They considered that climate models were not yet capable of predicting the nature of any regional shifts. Bengtsson et al. (1996) underlined the importance of the atmospheric circulation in modifying any effect of rising ocean temperature. These authors found, for example, that tropical cyclone frequencies in the Southern Hemisphere decreased as a result of global warming as weaker winds, reduced

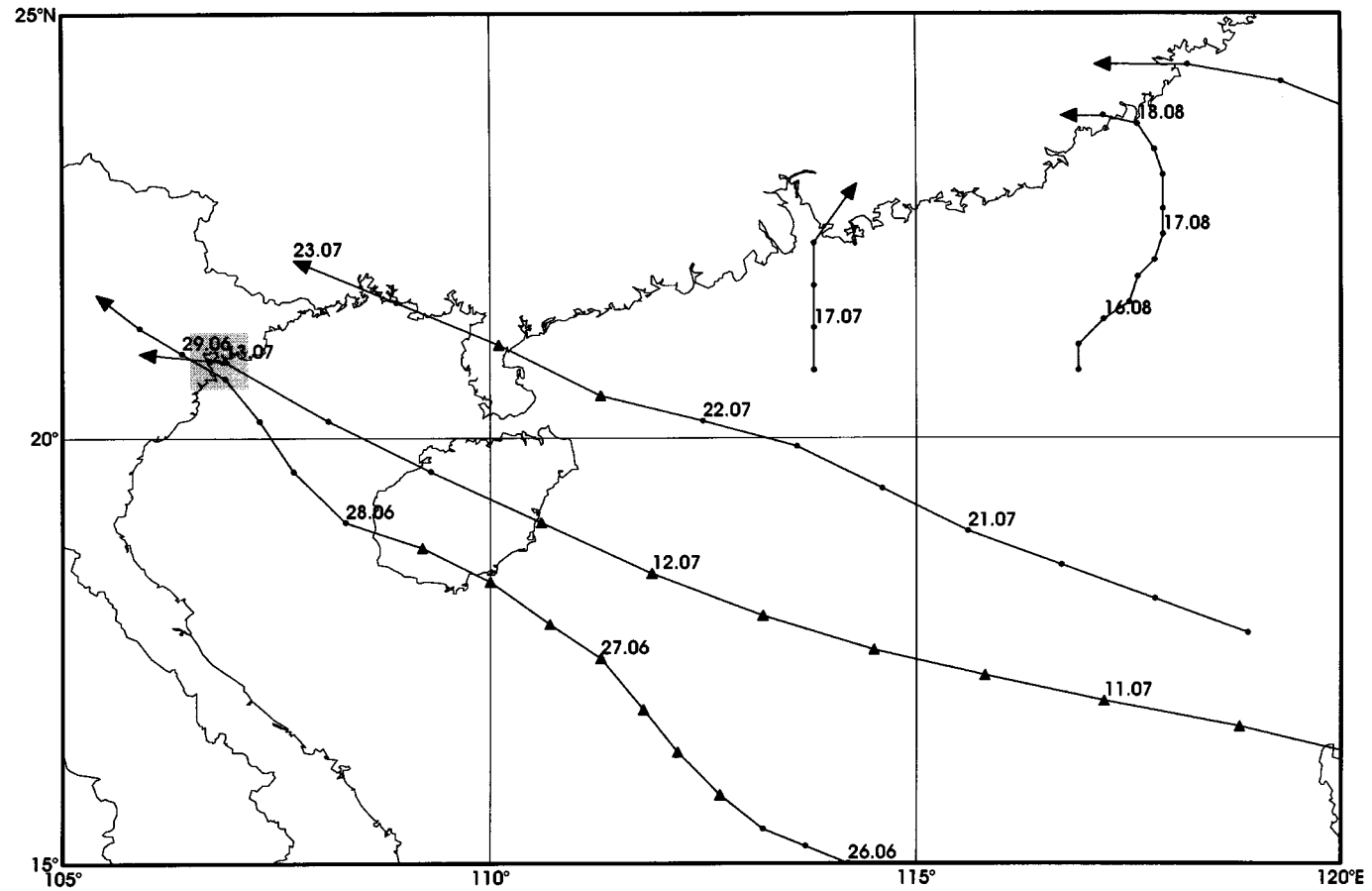


Figure 2. Tracks of tropical storms approaching northern Vietnam during 1992. Position is indicated every six hours. The triangles indicate points at which the storms were classified as typhoon force. Date is given as day.month (at 00Z). The box shows the location of the case study area in Quang Ninh Province, over which two storms passed two weeks apart.

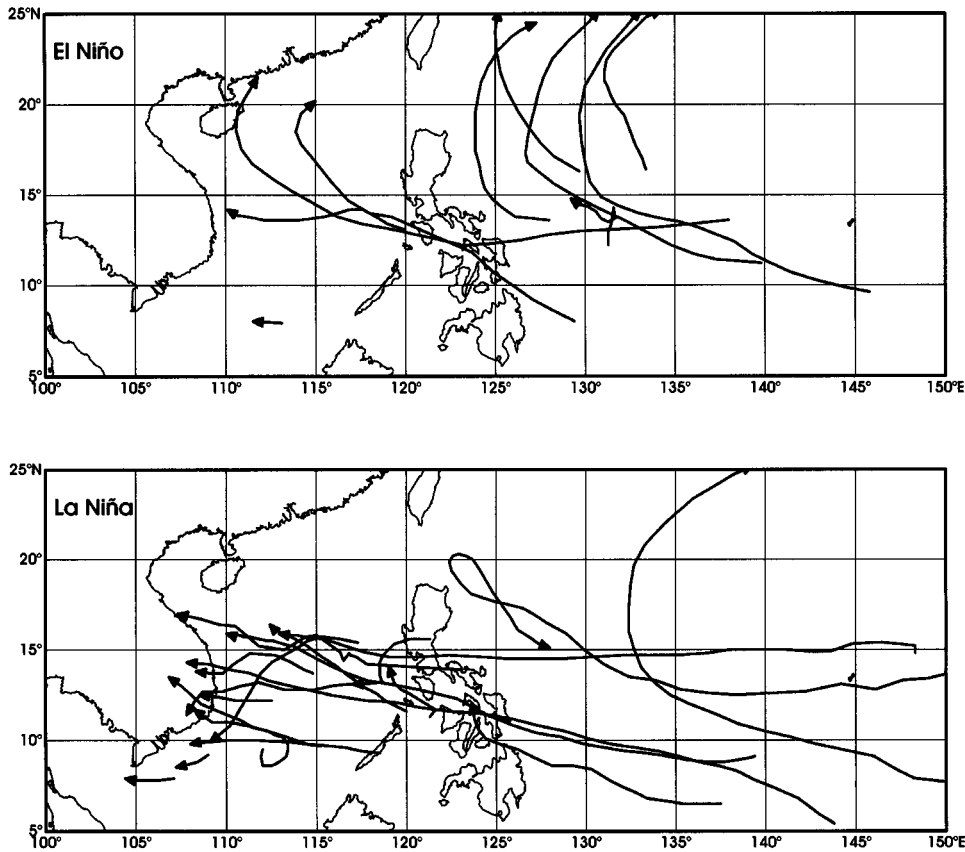


Figure 3. Tropical storm tracks for November during five years during which La Niña occurred (1964, 1970, 1973, 1984, 1988) and five years when El Niño occurred (1969, 1972, 1976, 1982, 1986).

evaporation and changing vertical stability offset any tendency towards increased numbers caused by higher sea surface temperature.

The IPCC Second Assessment Report (Houghton et al., 1996) was even more cautious than the earlier report: 'Knowledge is currently insufficient to say whether there will be any changes in the occurrence or geographical distribution of severe storms, e.g., tropical cyclones'.

The key reasons for uncertainty in the projections remain that:

- global climate models cannot adequately simulate tropical cyclones because, *inter alia*, their spatial resolution is limited; and,
- changes in the atmospheric circulation which may negate or modify the effects of rising temperature cannot be forecast with confidence for similar reasons.

At the local level, it is particularly important to predict shifts in the atmospheric circulation as these determine the regional distribution of storm tracks and, there-

fore, the risk along a particular stretch of coastline, regardless of any trend in total number over a sector as a whole.

Lack of understanding does not, of course, mean that a threat is not genuine, that a adverse change in cyclone characteristics will not occur. The fact that cyclone numbers vary greatly from year to year indicates that there is no immediate physical restraint on any long-term trend. And lack of knowledge, as interviews with Vietnamese informants suggest, does, in itself, heighten the perceived threat. Of course, the year-to-year variability also suggests that any global warming signal will not rise above the interannual noise for some time and, indeed, may not be significant from the point of view of its overall impact for many years.

The main conclusions of this assessment of the physical risk posed by present-day and future cyclone impacts are that:

- the present distribution of risk associated with cyclone landings presents a serious threat to human welfare; hence, reducing vulnerability to cyclone impacts is a major priority for the Vietnamese government (and has been for centuries for the Vietnamese people), providing an indisputable precautionary response to the longer-term, albeit uncertain, threat of long-term trends in storm characteristics;
- given the marked variability from year-to-year in storm characteristics and the centuries-long development of the storm protection system (Kelly et al., 2001), study of present-day (and historic) responses to the threat of cyclone landings should reveal abundant information of relevance to the related issues of vulnerability, coping and adaptation; and,
- given the uncertainty in the storm forecasts for a global warming future, it would be unwise to base assessment of vulnerability and response strategies on these estimates directly.

#### 4.3. THE SOCIAL DIMENSION

We now consider the results of the case studies undertaken in coastal areas at risk from cyclone impacts and draw conclusions regarding the pattern of social vulnerability and trends therein. The strategy for the collection of social science data during the fieldwork at the case study locations is outlined in Table II. Assessing vulnerability in the manner we have chosen does, inevitably, involve a considerable degree of data collection, reflecting the complexity of the processes being analysed.

The first major case study site is Xuan Thuy District in Nam Dinh Province (Figure 4). This is an agricultural district on the fringe of the Red River Delta in northern Vietnam, protected by artificial dykes and, in part, mangrove forest. In this area, the greatest number of typhoons and associated storm surges occurs, on average, in September and October, the so-called 'months of the shifting season' when the monsoonal current changes direction from southwest to northeast. Storm surges and sea level rise, as well as high waves and strong winds, may cause extensive damage to economic assets such as agriculture and aquaculture.

TABLE II  
Summary of social survey and data collection strategy

Vulnerability issue	Social data collection strategy
<i>Xuan Thuy, Nam Dinh Province</i>	
Social vulnerability indicators	65 household quantitative survey 30 household qualitative survey Semi-structured interviews with 20 commune and agricultural cooperative officials. Discussions with other key informants.
Mangrove rehabilitation as a risk minimisation strategy	Mangrove utilisation survey (3 districts). Local biophysical data on coastal geomorphology collated for quantitative model.
<i>Hoanh Bo and Yen Hung Districts, Quang Ninh Province</i>	
Mangrove property rights and migration issues under the transition.	150 household quantitative survey. 15 semi-structured interviews with province, district and commune officials.
Short-term storm warning and vulnerability	Participatory Rural Appraisal and semi-structured interviews with officials at province and district level and focused interviews with National Hydrometeorological Service. Visualisation of storm track for various typhoon seasons.

Observing the proxy indicators for vulnerability in this case study involved fieldwork in 1995 and 1996, investigating indicators in eleven communes (village-level administrative units) through household survey, based on a stratified area sample, and semi-structured interviewing of key informants (Adger, 1998, 1999a,b, 2000). Data for analysis of institutional adaptation and of institutional inertia in the treatment of present climate extremes in Xuan Thuy District were collected through semi-structured interviews of commune-level officials and from households within these communes, as well as discussions at the district level (Adger, 1998, 2000). A study of the costs and benefits of mangrove rehabilitation, a means of reducing vulnerability to storm impacts by increasing natural coastal protection, was also undertaken in Nam Dinh Province, based on data from the three coastal districts in the province: Xuan Thuy, Hai Hau and Nghia Hung.

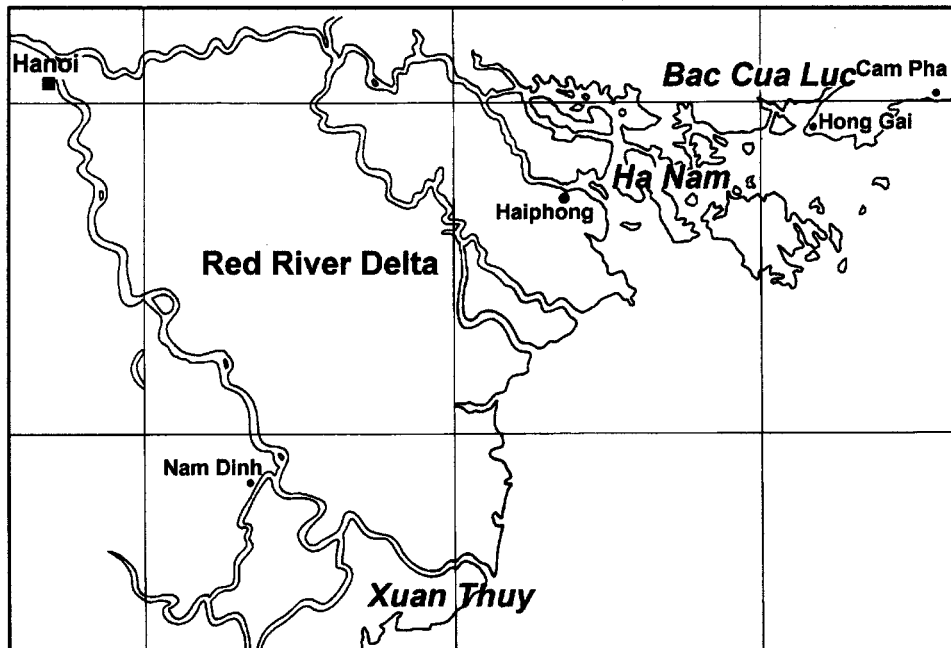


Figure 4. Location of the case study sites in northern Vietnam. The bulk of Xuan Thuy District has recently been renamed Giao Thuy District.

The two other major case study locations lie just north of the Red River Delta in Quang Ninh Province (Figure 4). Ha Nam island is located in Yen Hung District on the southern border of the province. This island, forming by the accretion of sediments over recent millennia, was first settled some 700 years ago by 19 families (whose names are still known). It is now home to over 55 000 people, growing rice and vegetables irrigated by water that comes by canal from a reservoir 15 km distant. Much of the island is below sea level – as much as 3 m below in some places – and it is only made habitable by the 40 km of dyke, up to 5.5 m high, that encircle it. It is known as the ‘floating boat’. The dyke has been designed to withstand a Force 9 storm. Whether or not it will provide protection against the more powerful cyclones that cross this area is critically dependent on the direction of storm passage and the timing of the storm surge with respect to the rise and fall of the tides. Local informants consider that a key dyke within the 7 km stretch of coast particularly at risk came within an hour of being breached in 1992; the tide turned just in time. Emergency provisions include a rescue boat for each household and progressive evacuation if any dyke is breached.

The central point for study at this site was the effectiveness of the storm protection system (Kelly et al., 2001). The device used was to follow the track of one storm and the response of the warning system all the way from Hanoi to Ha Nam island, providing insights into institutional processes under central planning

and communist government structures as they ultimately affect the local capacity to respond, as well as more direct influences on the local response. This research involved focussed interviews with staff of the Vietnamese Hydrometeorological Service and relevant national and international agencies in Hanoi, province-, district- and commune-level officials in Quang Ninh, and individual householders on Ha Nam island. The need to improve communications emerged as a key theme in this case study. Lack of contact with fishermen in small boats as a storm approaches heightens the vulnerability of this section of the community; above-ground telephone links are often lost as a storm passes over, seriously affecting command and control; and communication between the various institutional players is critical at and between all administrative levels. Communication constraints increase collective vulnerability.

The third site investigated was further north in Quang Ninh Province, an area known as the Bac Cua Luc wetland lying in Hoanh Bo District. In this province, as elsewhere, there has been a trend towards privatisation of assets which were previously either managed by the state through co-operatives or were traditionally under common property rights, particularly in lowland and coastal Vietnam (Adger et al., 1997a, 2001). Mangroves are one of the coastal resources which have been privatised to a large extent. In Hoang Bo District, an area of about 1200 ha of mangrove is being converted for agriculture and aquaculture as part of a two-stage plan involving the loss of about 1900 ha of mangrove in total. The research was undertaken through household interviews in the neighbouring communes of Le Loi and Thong Nhat and interviews with informants at the local, regional and national level. The conversion is being undertaken through state subsidy and the land reclaimed will be used to resettle households from densely-populated parts of the Red River Delta. One third of the area allocated to aquaculture will be retained, as payment, by the construction agents to whom it is currently leased or sold off to private individuals on a ten-year lease. The aim of this case study was to examine the potential impact of mangrove conversion on the social vulnerability of the local inhabitants. The key issue is the consequences for the livelihoods of the local people when their property rights, to the mangrove in this instance, are overturned by state decree with support by state subsidy. Again, a chain of institutional processes was considered, from the national to the local level.

The context for these studies is the process of *doi moi*, underway since the late 1980s. *Doi moi*, literally 'new change', can be interpreted as 'renovation'. The process, resulting in marked economic growth sustained even through the crisis in Asian economies beginning in 1997, has involved privatisation of the state-owned industries and of major product and marketing organisations, price reform, and major changes in property rights in the agricultural sector. At the same time, political control has been retained by the Communist Party. *Doi moi* is having a profound effect on the capacity of the agrarian communities to respond to environmental stress, particularly with regard to the rapidly changing institutional structure of collective action.



In the following sections, we explore particular themes emerging from these studies that throw light on the factors which influence social vulnerability and on the process of adaptation. What emerges is a perspective on vulnerability as a state that continually evolves, not only because the technological and institutional factors that shape vulnerability are themselves in a state of constant flux but also because humanity constantly experiments with new ways of responding to change.

#### 4.4. THE ARCHITECTURE OF ENTITLEMENTS IN PRACTICE

Analysis of the household-level data from the Xuan Thuy study, reported in Adger (1999a,b), reveals the complex mesh of factors which shape the vulnerability of a community as social and economic trends reinforce, transform or weaken existing patterns of risk.

- Overall, Xuan Thuy is, in rural Vietnamese terms, a relatively wealthy and productive district with a low incidence of absolute poverty and might be considered, from this isolated perspective, less vulnerable in the context of rural Vietnam as a whole – based on household survey data from the case study area and the World Bank (1995) living standards survey for the other regions, 18% of households in Xuan Thuy District fall below the basic needs poverty line compared to 49% in the Red River Delta as a whole and 57% throughout rural Vietnam (Adger, 1999a).
- Poorer households are dependent on a narrower range of resources and income sources and are thus more vulnerable, in the context of the local population, as they have reduced access to resources for coping with extreme events, such as credit sources, and are more reliant on activities such as salt-making which could potentially experience a significant impact in the face of coastal flooding (and other climate shifts such as an increase in cloudiness) – the survey results show not only that poorer households tend to have fewer sources of income (lacking, in particular, income from aquaculture, wage labour and remittances) and less land for rice production but that income from saltmaking is *negatively* correlated with overall household income (Adger, 1999a).
- The distribution of resources within the district is relatively even compared to many agrarian societies but is less even than in other parts of rural Vietnam and underlying inequality (both between individual households and between the coastal and inland communes) is increasing due to the emergence of capital-intensive commercial activities, principally aquaculture, in the period since market liberalisation – the value of the aquaculture industry rose from zero in 1988 to about three times that of agricultural production by 1993 (Adger, 1999b).

The increasing dependence on aquaculture is having complex effects on levels of vulnerability. On the one hand, it should increase the overall wealth of the district with trickle-down effects benefiting the population as a whole but, on the other

hand, it is heightening levels of inequality, as noted, and tying up capital in an inherently risky venture as shrimp farms are seriously exposed to storm impacts.

The parallel analysis of institutional issues reveals how access to decision-making is a critical factor in this instance (Adger, 1998, 2000). The government institutions of the district have taken advantage of increased autonomy as a result of *doi moi*, but have become less directly influential in resource use since agricultural land has been allocated to private individuals and private enterprise encouraged. There has been a reduction in the resources available for sea dyke maintenance as monetarisation of the previous labour-based system has permitted the diversion of finances away from dyke maintenance and into, for example, road building in the coastal communes, i.e., the development of infrastructure to support economic growth. The inland communes are not aware of this shift in investment in collective security; they are persuaded by the coastal communes that the maintenance programme is being maintained at former levels and gives sufficient protection. In this way, formal institutions are seeking to maintain their resources, powers, and their authority in a time of rapid change at the expense of collective security. The research also shows that informal institutions have offset some of the negative consequences of market liberalisation and the reduction of the role of government by evolving collective security from below, for example, through risk spreading in credit unions, particularly in fishing communities.

The Xuan Thuy study demonstrates the difficulties in generalising about levels of vulnerability even in a relatively small community. We do not consider it wise to attempt to determine the overall impact on levels of vulnerability of the socio-political trends currently underway. It is, however, possible to identify causal linkages and to identify measures which might compensate for adverse effects and reinforce beneficial consequences. The dynamic nature of vulnerability in this community underlines the difficulties in projecting vulnerability estimates, and the underlying social, economic and political processes, decades into the future.

#### 4.5. SPONTANEOUS ADAPTATION – WIN-WIN IN ACTION

The mangrove ecosystem plays an important role in the lives of the inhabitants of the coastal zone, providing a range of goods and services, including storm protection, staple food plants, fertile grazing land, protected nurseries for coastal and offshore fisheries, pollution control, breeding grounds for numerous birds, and fuel from peat amongst other marketable products. The functions and services provided by mangroves do have positive economic value, but this is often ignored and mangrove forests are frequently damaged or destroyed (Barbier, 1993; Ewel et al., 1998; Naylor and Drew, 1998). The rehabilitation of mangrove areas can provide a dual benefit in improving the livelihood of local users as well as enhancing sea defences (Field, 1998), providing a precautionary, win-win approach to climate impact mitigation.

In order to quantify the economic benefits of mangrove rehabilitation, we assessed the particular costs and benefits of rehabilitation in three coastal districts of Nam Dinh Province (Adger et al., 1997b; Tri et al., 1998). The analysis contrasted the costs of mangrove rehabilitation, that is, purchase of seeds, planting and maintenance, with the resulting benefits in terms of improved local livelihoods (increased income from wood production, fishing and bee-keeping) and the reduction in dyke maintenance. (Benefits in terms of any wider reduction in storm impacts on agriculture, infrastructure and so on were not considered.) Rehabilitation costs and livelihood benefits were derived from estimates of labour requirements, observations in local markets and other survey data. The savings in terms of dyke maintenance costs were calculated using an empirical model.

The planting of mangroves seaward of a sea dyke system reduces the cost of maintaining these defenses. Mangrove stands provide protection from wave action by creating a physical barrier, stabilizing the sea floor and affecting the angle of slope of the sea bottom. Studies in southern China have resulted in an empirical relationship through which the benefit, in terms of avoided cost, can be expressed as a function of the width of the mangrove stand (as a proportion of the average wavelength of the ocean waves that the stand is exposed to) and various parameters related to the age of stand (mangrove size and density) expressed as a buffer factor; the relationship has been tested and modified for mangrove stands in Vietnam (Vinh, 1995) and was used in this study (see Tri et al., 1998, for further details). Dyke maintenance takes place in coastal Vietnam through the obligatory labour of district inhabitants each year. These commitments can prove a serious imposition on labour-scarce households and the inter-district allocation of labour contracts has proved a source of conflict (Adger, 1996). The system is now evolving under the influence of *doi moi*; individuals may, for example, be permitted to buy themselves out of the labour obligation.

The economic analysis of costs and benefits shows that rehabilitation is desirable from an economic perspective based *solely* on the direct benefits of use by local communities, that is, without consideration of benefits related to dyke maintenance (Figure 5). The rehabilitation schemes obviously have even higher benefit cost ratios when the indirect benefits of the avoided maintenance cost of the sea dyke system are taken into account. The results show a benefit to cost ratio in the range of four to five, relatively insensitive to discount rate as most of the costs, as well as the benefits, occur within a relatively short time frame. Though this analysis is subject to various limitations (see Tri et al., 1998, for further discussion), the results strongly suggest that mangrove rehabilitation should be an important component of a sustainable coastal management strategy.

Through examination of the reverse process of mangrove loss, the case study of the Bac Cua Luc wetland in Quang Ninh Province demonstrates which element of the local population is most affected by mangrove conversion and, as a corollary, would benefit most from mangrove rehabilitation. Traditionally, mangrove areas were commonly owned and managed, and because their value was collectively

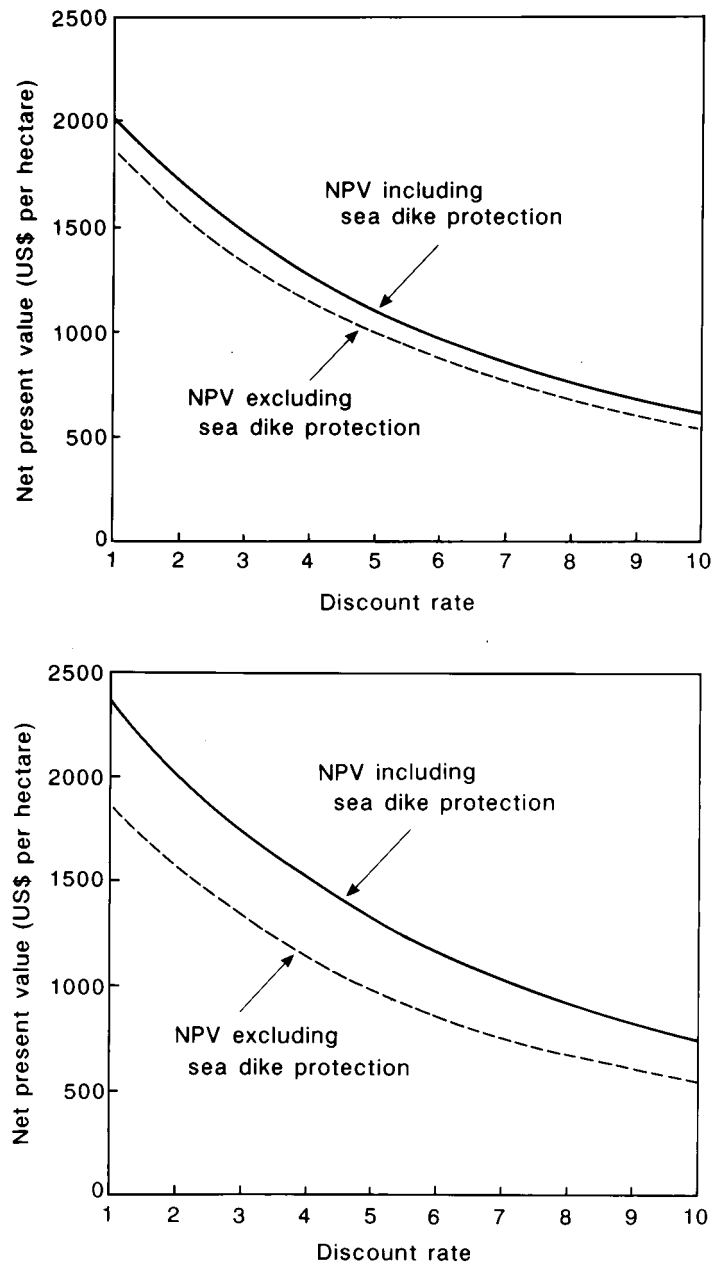


Figure 5. Net present value of mangrove rehabilitation, including value of sea dyke protection, for two cases: upper) stand width = 100 m; incident wavelength = 75 m; lower) stand width = 33.3 m; incident wavelength = 25 m. From Tri et al. (1998).

appreciated, they were cared for, as has been shown, for example, in Indonesia and throughout Southeast Asia (Adger and Luttrell, 1998). Analysis of household-level data from the communes neighbouring the converted and remaining areas of wetland shows that the poorer households rely on the mangrove more for their livelihood than the wealthy, who are more interested in the private commercial activity utilising of the coastal resources. The ability of the community to maintain sustainable common property management of the remaining mangrove and fishing areas is undermined by changes in the property rights and changes in inequality brought about by externally driven enclosure and conversion. At the household level, the poor, dependent, families suffer disproportionately with the loss of the habitat functions. But at the community level, there is also a loss of resilience as families compete for the remaining resources, leading to non co-operation in use of the ecosystem. As some families gain in the new commercialism, others disproportionately lose since they have no fallback when the formerly commonly managed resource is denied them. By this means, in the absence of compensatory action, vulnerability is exaggerated, resilience is undermined and adaptive options are lost (Adger et al., 1997a, 2001).

#### 4.6. OPPORTUNITIES FOR INTERVENTION

The process of *doi moi* provides a valuable chance to observe how rapid socio-political change might affect levels of vulnerability and adaptive possibilities. This understanding can also lead to recommendations regarding macro-level policies which might reduce vulnerability and facilitate adaptation.

It is clear that the economic changes accompanying *doi moi* have increased the opportunities for income generation in the coastal communities that we have studied while increasing differentiation within these communities (see also Hirsch and Thinh, 1996, for example). As far as the richer section of the community is concerned, economic reform is perceived as having a positive effect in terms of reducing the risk associated with present-day hazards. Indeed, it may be considered to have reduced the vulnerability of the community as a whole. As we have shown, though, assessing overall effects on a community is not a simple matter. Even a single socio-political shift can generate a complex set of consequences across a population. Moreover, there may be substantial divergence in consequences within a community. So, in the coastal communities we have studied, economic growth has been accompanied by substantial investment in an inherently risky venture, aquaculture, which, the risk of storm impacts apart, has been shown to be unsustainable in many parts of world (Folke and Kautsky, 1992). And levels of inequality within these communities have clearly been heightened. In related developments, the rights to common resources such as the mangrove forest have been lost and institutional changes have reduced the efficacy of various forms of collective action and investment. These trends have their major impact on the poorer members of the community, who rely on the mangrove ecosystem to supplement their livelihood

and on collective action to provide protection against stress and support in times of hardship.

Other changes affect the community as a whole. For example, evidence from the Ha Nam island case study suggests that the local-level storm warning system is under greater pressure, embedded as it is in the agricultural co-operative and hierarchical government structures that are presently being 'rolled back' (Kelly et al., 2001). This can be seen in the charging for certain meteorological forecasts previously provided free and in the possibility of opting out of the requirement to provide labour for dyke maintenance, on payment of a tax, that has left some districts unable to cover the costs of hiring replacement labour. There is concern that the development of regional centres within the Vietnamese Hydrometeorological Service structure, aimed at improving efficiency, may reduce the role of the local meteorologists on whose expertise there is heavy dependence at the district and provincial level. Study of developments at the national level with regard to the storm warning system revealed other institutional processes affecting the efficiency of the system and hence vulnerability: for example, inter-agency conflict, particularly between national and international institutions, and cultural difficulties in the adoption of foreign technology and methods as well as a perceived lack of respect for established practice on the part of foreign consultants (Kelly et al., 2001). In compensation, of course, greater wealth in the local community should eventually support more effective coastal protection and the technological infrastructure of the storm warning system has improved notably in recent years.

Other trends have reduced levels of vulnerability by increasing access to resources. Diversification of income sources is an effective means of reducing vulnerability by spreading risk and *doi moi* has promoted income diversification in a number of ways. First, it has created the opportunity for private investment as well as new employment options. Second, labour mobility is now permitted, opening up possibilities for migration on a seasonal or permanent basis. Remittances from relatives working away from home provide an important means, the Xuan Thuy case study suggests, of improving access to resources. The accumulation of capital in private hands has resulted in the return of private credit as a coping strategy and informal community-based institutions, street committees and so on, have also returned replacing some of the risk-pooling functionality of more formal structures which are losing their effectiveness and influence.

What lessons can be learnt from this research regarding policies that might reduce vulnerability and facilitate adaptation? Some conclusions are specific to the circumstances of these particular case studies. There are, however, a number of strands that are of wider applicability concerning the promotion of measures that might improve the situation of the poorer members of these and other communities, the people we fear are increasingly at risk as a result of recent socio-political trends:

- poverty reduction clearly must be a priority, though that alone may not be sufficient to ensure the wider access to resources necessary to reduce vulnerability;
- risk-spreading through income diversification can be promoted in a number of ways and, again, will assist mostly the poorer members of the community;
- the loss of common property management rights represents a serious erosion of the ability to resist stress and, where it cannot be avoided, compensatory measures should be implemented; and
- the reduced efficiency, or loss, of forms of collective action or investment affects the community as a whole and this process warrants careful monitoring with efforts to promote the development or resuscitation of other, perhaps traditional, forms of community security.

At a deeper level, the underlying causes of vulnerability must be tackled if we are to develop a sustainable response to extreme events and climate change. It will be necessary, for example, to address directly the maldistribution of resources. This is a widespread issue. Wisner (1978) argues that the insecure land tenure regime and the resulting perceived insecurity has been the major cause of large-scale flood impacts and mortality on the low-lying delta areas of the Ganges-Brahmaputra-Meghna (see also Brammer, 1993; Blaikie et al., 1994). Given the political nature of resource distribution and the role of institutions within such processes, institutions which themselves must evolve to support more effectively the response to stress, is it realistic to propose wealth redistribution and land reform, for example, as policy recommendations? On the one hand, social hierarchies and resource and entitlement inequalities are rarely overturned in the course of adaptation, and external changes such as climatic extremes and other natural hazards tend to reinforce those inequalities (Cannon, 1994). On the other hand, radical policy alternatives do sometimes coincide with the requirements of élites (Bardhan, 1996). For example, the political necessity to retain rural support for the present government in Vietnam has ensured a relatively equitable privatisation of agricultural land, particularly in the intensive agricultural lowlands, compared to many other former centrally-planned economies and other agricultural areas at risk from climatic hazards. Under particular circumstances, land reform and equitable redistribution can offer a viable policy option for tackling the underlying causes of social vulnerability – but they represent a substantial challenge, nevertheless.

## 5. Conclusions

We have defined social vulnerability in terms of the capacity of individuals and social groupings to respond to – that is, to cope with, recover from or adapt to – any external stress placed on their livelihoods and well-being, focussing on socio-economic and institutional constraints that limit the ability to respond effectively.

Vulnerability is intrinsically linked to the process of adaptation through this definition; adaptation is facilitated by reducing vulnerability. We have demonstrated that this conceptualisation of vulnerability can be operationalised through analysis of the architecture of entitlements, that is, access to resources, providing an effective framework for analysis and leading to policy-relevant conclusions and recommendations. Case studies in northern Vietnam have revealed a wide range of factors that influence levels of vulnerability, ranging from poverty and inequality to communication difficulties and cultural barriers. They have also revealed the complexity of the processes that shape vulnerability, suggesting that we are far from the level of understanding that would permit a detailed model of how vulnerability is constructed to be advanced.

The value of diverse approaches to a threat as complex as global warming means that it would be foolish to argue that any one framework for analysing vulnerability should become the dominant discourse. The approach that we have adopted may not be the most appropriate, for example, if a composite index of vulnerability is required for comparative purposes. Nevertheless, we do see distinct advantages to the conceptualisation of vulnerability developed in this article from a policy point of view, both in terms of the robustness of the conclusions and the manner in which the framework reconciles the demands of immediate aspirations and long-term environmental security, providing recommendations for action of immediate relevance. The fact that this approach deals with processes at the level of the household and community, while mitigating against aggregation to larger scales (Adger and Kelly, 1999), highlights the great differences in levels of vulnerability that can occur within a nation. We strongly endorse Kates' conclusion that 'if the global poor are to adapt to global change, it will be critical to focus on poor people, and not on poor countries as does the prevailing North-South dialog. The interests of the poor are not always the same as the interests of poor countries, since in the interest of "development", the poor may grow poorer' (Kates, 2000).

The case studies illustrate the many and varied opportunities for intervention. The most effective and sustainable form of intervention, we suggest, would be to detect, then cautiously reinforce, modify or offset, trends in the factors that limit or enhance vulnerability as they emerge. Given that we are working within a framework based on analysis of entitlements, the net effect of this kind of intervention should be to empower directly those likely to be affected by climate stress, a very desirable result. We have highlighted four measures, of broad relevance, that could be taken now to improve the situation of the most vulnerable: poverty reduction; risk-spreading through income diversification; the preservation of common property management rights; and the promotion of collective security. Finally, we raise the challenge of addressing the fundamental causes of the maldistribution of resources.



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