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Institute for Social and Environmental Transition - Nepal

Working with the Winds of Change

Toward Strategies for Responding to the Risks Associated with Climate Change and other Hazards

Second Edition

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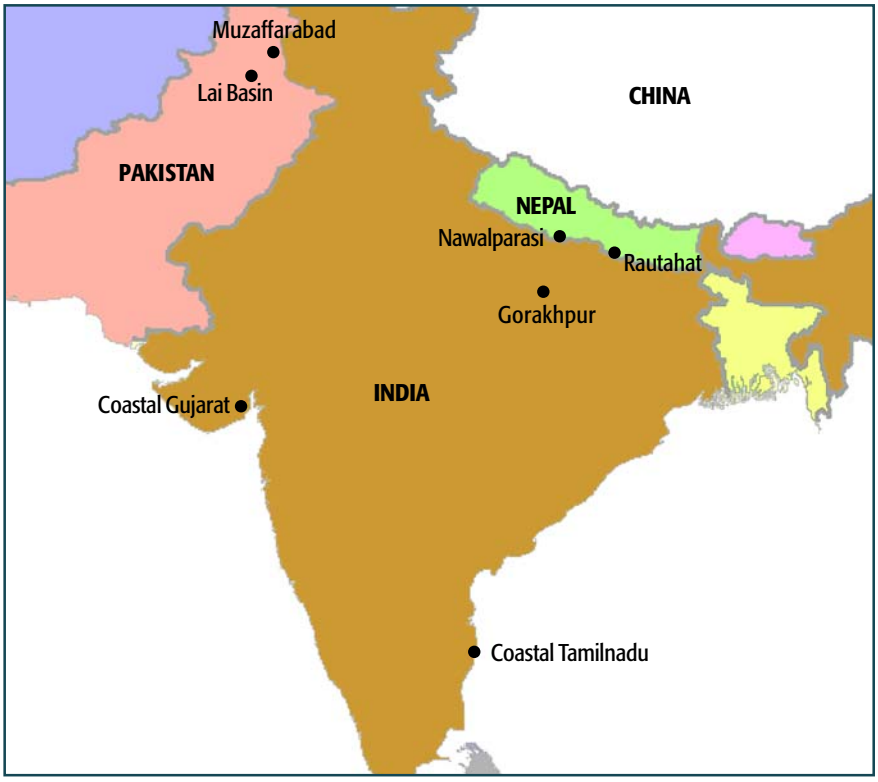
Study Sites in India, Nepal and Pakistan



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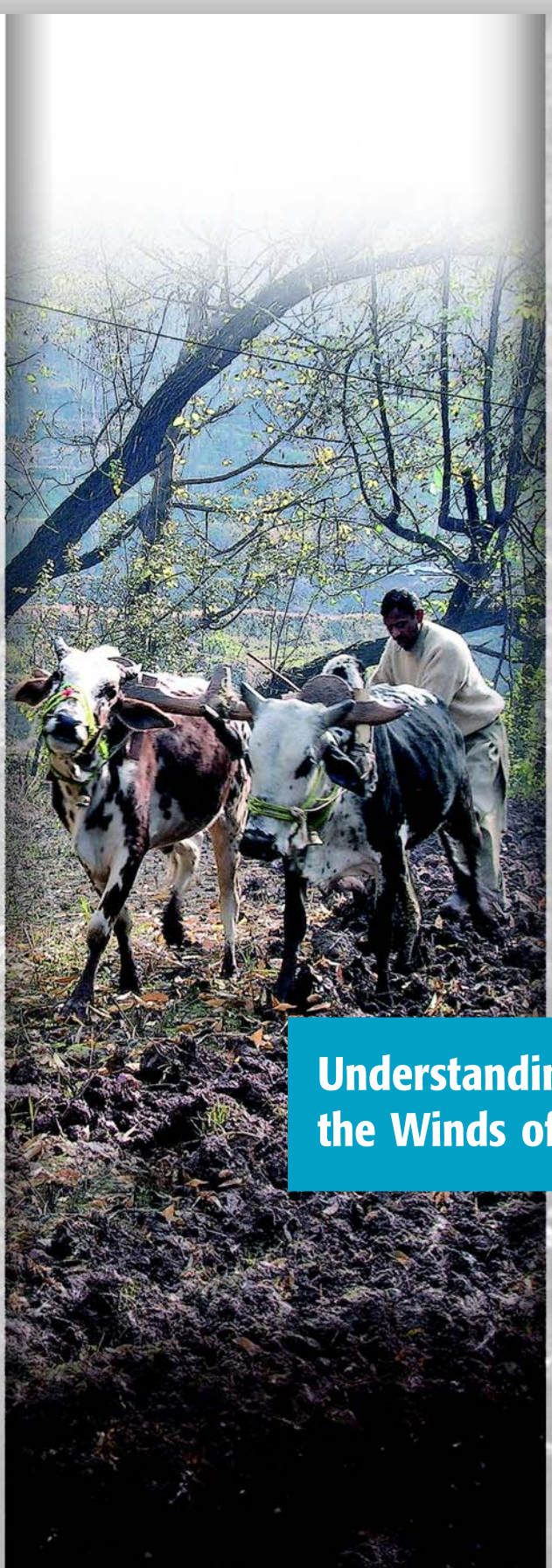

CHAPTER 1

Understanding the Winds of Change

Marcus Moench and Ajaya Dixit

Introduction

The challenges posed by translating global projections of climate change or the need for disaster risk reduction into courses of action that can be implemented at local levels are complex.

We live in a world increasingly dominated by transformative change processes: stories of disasters pervade the daily news and the recent IPCC summary report (2007) highlighted the fundamental threat to society posed by climate change. Adaptation and disaster risk reduction, previously academic topics of interest only to specialist groups, are now common currency in policy debates, the media and public dialogue. Few, if any, people (ourselves included) have a comprehensive understanding of what climate risk reduction or adaptation to the impacts of climate change may actually entail.

The future has always been clouded, but it is even more so now. Some seek certainty regarding the likely impacts of climate change in ever more detailed scientific projections. While such projections may provide important insights, we believe that they are, for reasons related to the chaotic behaviour of social and natural systems, unlikely to provide the precision often sought. The accuracy of such models is confounded by imprecise measures of initial and boundary conditions, and their ability to map the implications of global conditions onto the complex mosaics that characterise local contexts is limited. Natural scientists and engineers trained to demand specific flow projections in order to design control structures may now be asking the wrong question. Control has, perhaps always, been an ephemeral and unrealistic goal. Living with uncertainty and change may be more realistic, but the question is how?

The challenges posed by translating global projections of climate change or the need for disaster risk reduction into courses of action that can be implemented at local levels are complex. In the past, millions of dollars were invested in climate research, primarily in developed countries. This research has yielded significant dividends: a knowledge base that conclusively demonstrates that climate systems are changing in fundamental ways as a consequence of human activities and that such change will affect regions across the globe. It is highly likely that regional changes in climatic patterns will occur.

More specifically, rises in sea-level, increases in storm intensity, changes in climatic variability and increases in droughts, floods and other extreme climatic events are very probable. While climate models and the insights they provide have immense value, models, however, aren't sufficient because they cannot predict precisely where, when or with what intensity events will occur in specific regions. Climate events, as with the occurrence of other extreme hazards – from earthquakes to the collapse of stock markets – will always contain a fair degree of surprise. Developing effective systems to deal with such surprises and to reduce their impact continues to remain a challenge. Concepts of adaptation to climate change and disaster risk reduction need to be translated into practical strategies so that they do not become jargon similar to the many other buzz words that have littered global development debates for a brief period and then faded as political attention wanes. If the concepts of adaptation and disaster risk reduction fade, human societies will forego a future and millions of people will pay with their lives. The challenge is real and fundamental.

This report, a preliminary step in a much broader programme, presents some initial insights from methodological investigations and field studies which explore the link between disaster risk reduction and adaptation to climate change. The impacts of climate change are almost certain to be pulsed. Gradual declines in rainfall within regions will become evident when they translate into prolonged drought. Gradual rises in sea-level will reshape coastal regions when, as Hurricane Katrina did, coastal defence structures are overwhelmed. Such surges will engender both destruction but also windows of political and social

The impacts of climate change are almost certain to be pulsed.

Coastal Tamilnadu

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opportunity to deal with surprises. The pulsed nature of the impact of Katrina, for example, has focused attention on spatial planning issues – moving people out of harm's way. Many advocate relocation in order to minimise the impacts of climate change and reduce disaster risks. However well meaning the approach, there is no denying that it is difficult to tell a small farmer in Bangladesh or a family in the poor quarters of New Orleans that they must give up their only assets and move. Movement will occur, however, whether voluntary or involuntarily, as it did following Hurricane Katrina. Much of this movement is likely to occur in pulses as people are either forced from their place of residence or, when the hazard is brought to their direct attention by an event, choose to move.

Strategies for working with pulsed change – incorporating reduction of future risks in the process of post-disaster reconstruction – are essential.

Ethically, risk reduction *should* occur proactively where hazards are clear. Practically, it is unlikely to. *That something should happen* and *that something can happen* are not equivalent. Furthermore, in many cases proactive responses make little sense. Even well-informed urban residents with substantial technical competence may see little reason to respond before extreme events destroy existing systems. The U.S. Environmental Protection Agency, for example, has identified hundreds of municipal wastewater systems in Florida that will need to be redesigned as sea-levels rise, but since these systems may work for decades before they become non-functional, redesign only makes sense following either their destruction during an extreme event or at the end of their functional lifespan. In any case, if sea-levels rise more rapidly than anticipated, the adaptation process in Florida will need to involve far more transformative changes than simply rebuilding sewer systems. Entire communities would need to be relocated rendering their old and any newly designed sewer systems irrelevant. As a result, strategies for working with pulsed change – incorporating the reduction of future risks into the process of post-disaster reconstruction – are essential.

This said, as ProVention has documented elsewhere, existing experience with risk reduction in reconstruction contexts has been far from encouraging. Political constraints in the reconstruction process are major and it is often difficult or impossible to incorporate risk reduction measures. As discussed further in the overview chapter, it may be possible to address such limitations through proactive planning for reconstruction in hazard prone areas - effectively linking proactive identification of potential risk reduction measures with the need and opportunity for reconstruction that can accompany major events. Furthermore, it is equally important to emphasise that disaster risk reduction in advance of likely events should be used as a proactive measure. Retrofitting of buildings, upgrading of flood protection measures, spatial planning (zoning to reduce exposure in areas vulnerable to hazards), economic diversification away from vulnerable livelihoods, many such measures can and should become central within existing environments as well as a feature in new investments.

Strategies able to respond to the diverse contexts in which climate impacts and disasters occur must also be developed. Risk is inherently local. Shaped as they are by factors as diverse as topography, social stratification and gender, most risk vectors lie below the radar screen of national governments. This invisibility

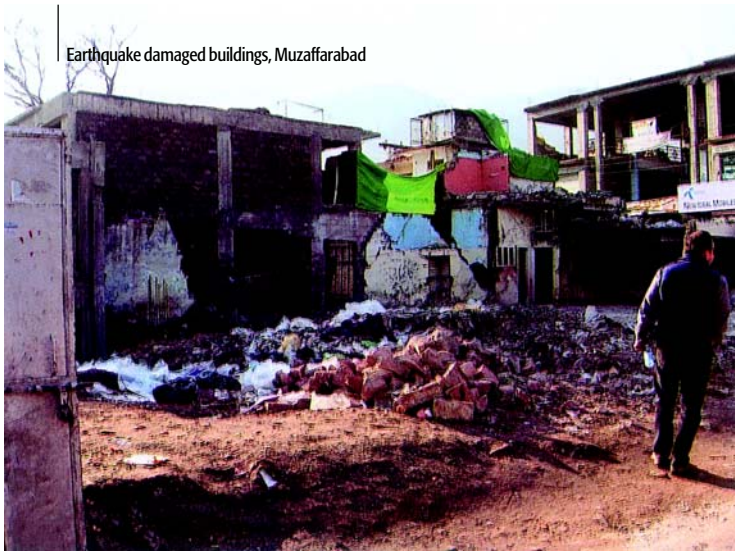
poses major challenges for the development of national or regional programmes which target specific hazards, because such approaches must be tailored to specific local contexts. When events occur infrequently, however, such specific approaches are difficult to maintain. At a deeper level, however, risk and the ability to adapt are shaped by the underlying systems that enable populations to respond and shift strategies in relation to specific events or changing conditions.

The studies presented in this report illustrate the various roles that approaches targeted toward hazard-specific and underlying systems can play in diverse contexts and in response to multiple hazards. At the time of writing, fieldwork was ongoing on coastal regions of Tamilnadu and Gujarat, portions of the Gangetic plain falling within both India and Nepal, and in Pakistan, in the urban area of Islamabad and the hill zones of Muzaffarabad devastated by the 2005 earthquake. This report presents initial results from many of these areas with a particular focus on the methodologies currently being developed and used. It also focuses on the climate change element, specifically the degree to which existing climate projections can provide useful insights into more appropriate disaster risk reduction strategies for each areas.

The report is organised in the following manner: The first chapter provides an introduction. The second chapter presents concepts related to climate adaptation and disaster risk reduction. It then explores the implications of those concepts for the financial viability of various risk reduction strategies before concluding with an overview of the approaches we are developing for translating concepts into a practical basis for action. The third chapter provides a detailed analysis of existing scientific information on the impacts climate change may have for the monsoon in the Indian subcontinent. Two methodology chapters (four and five) follow, focusing respectively on vulnerability analysis and shared learning dialogues (the techniques we are using to translate climate and other hazard information into a practical basis for strategy identification). These two chapters emphasise both the strengths and limitations of evolving methodologies and explore potential avenues for their improvement. The next four chapters (six, seven, eight and nine) are devoted to case studies that illustrate both the use of existing methodologies and the strategic insights they have generated in specific locations. The first five chapters of this publication provide conceptual and policy level insights, while the next four chapters provide lessons for practitioners. Some of the insights into and the implications for the development of effective ways forward are summarised in the next section.

Approaches must be tailored to specific local contexts.

Earthquake damaged buildings, Muzaffarabad



Key Issues

Shared learning processes represent a cornerstone in any effort to address the risks associated with climate change and other natural hazards.

Reducing disaster risks, particularly those likely to emerge as a consequence of climate change, is a long-term process. Contexts are evolving continuously – and not just in response to climate conditions. Capacities are also growing as technological change, globalisation, and processes of institutional evolution reshape the underlying systems on which local societies run. Furthermore, new knowledge about the nature of climate and other hazards, patterns of vulnerability and the effectiveness of alternative strategies for reducing risk is continuously emerging at different scales. The dynamic, multi-level nature of change processes makes shared learning essential.

Unless emerging knowledge can be shared among regions and communities and across time, strategies cannot evolve in ways that reflect changing conditions. As a result, shared learning processes represent a cornerstone in any effort to address the risks associated with climate change and other hazards. What is a shared learning dialogue process? In essence it is a set of meetings in which information and perspectives are transferred between groups (from experts and government actors to communities and vice versa) in an *iterative* manner that, over time, builds shared understanding of the complicated, multi-dimensional nature of risks and the potential responses to such risks. The importance of shared learning may seem self-evident, but we have emphasised it here because it has basic implications that include but go beyond the widely accepted strategy of community participation and stakeholder involvement in risk reduction. In particular, the need for shared learning underpins the importance of balancing methodological approaches while communicating key information about risk, vulnerability and the viability of various strategies. The points below relate directly to the need for shared learning:

1. **Recognition of the strengths and limitations of both narrative-based approaches such as vulnerability and capacity analysis and quantitative methodologies.** Narrative approaches capture nuances that shape the transformation of physical hazards into patterns of risk and vulnerability for various groups but they have functional limitations. In particular, they are difficult to translate into a functional basis for decision-making

Breached embankment along Rohini River, 2007 monsoon.

in policy and economic contexts. Decision makers often give credence – and for very good reasons – to quantitative measures, which can be mapped in relation to the number of people and geographic factors involved. In addition, if the basis for quantification is explicitly described, such measures can be more transparent than narratives. Our own experiences with shared learning dialogue approaches are outlined in Chapter 5. These experiences illustrate how qualitative narrative approaches often require as specialised expertise in order to implement and interpret them as more quantitative approaches. Quantitative measures are limited as narratives, but in a different way: How questions are framed; who controls, selects and analyses data; the tendency to ignore factors which are difficult to quantify; the propagation of errors; hidden assumptions and a heavy reliance on analytical technologies that are not accessible to stakeholders are all limitations. *Given their inherent limitations, quantitative and qualitative measures must both play balanced roles in vulnerability and capacity analysis if such analysis is to provide an operational basis for action.*

2. **The need to improve and utilise qualitative and quantitative estimates of the cost and benefits of alternative strategies for risk reduction under changing climatic conditions.** Since the process of cost-benefit analysis (CBA) requires

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Sand deposition in paddy field following the breach, 2007.

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Submerged pumpset in paddy field 2007 monsoon.

clarifying the assumptions on which the investments in risk reduction are based such analysis can be a key technique for forcing an evaluation of those assumptions, a central element in the learning process. Furthermore, quantitative and qualitative estimates can provide a relatively standardised baseline for learning across projects and regions. These methods can also help to incorporate questions of equity that CBA often fails to address. These additional benefits are, we believe, as important as the financial justification CBA may or may not provide for guiding investment decisions.

Hard resilience measures, such as embankments or coastal levies, are – as the experience of Hurricane Katrina demonstrated – often subject to catastrophic failure when conditions exceed design parameters.

3. **Development of frameworks that assist in relating specific courses of action to the underlying concepts that shape understanding of risk, vulnerability and adaptive capacity.** A tremendous array of activities and strategies are currently being discussed at global and local levels under the rubric of disaster risk reduction and climate adaptation. Debates regarding the role of communities, the private sector, civil society, non-government organisations and governmental actors are intense and often divided along ideological lines. We believe that such debates can be clarified (if not resolved) and translated into practical courses of action that relate potential interventions to (a) the role they play in reducing risk and supporting adaptation either *directly* or at *systemic* levels; and (b) the operational (or business) models they imply. Direct measures involve interventions (such as structures, disaster management organisations, and insurance) that are specifically designed to address emerging or known risks. Systemic measures, for their part, strengthen, diversify and improve access to the communication, transport, financial, organisational, governance, livelihood and other capacities that influence adaptive capacity and vulnerability.

4. **Increasing understanding of the relative strengths and weaknesses of soft and hard resilience.** Most approaches to disaster risk reduction focus on hard resilience – the physical strengthening of structures and other control measures – designed to deflect the impact of extreme events. Soft resilience strategies, in contrast, emphasise increasing the flexibility of systems to respond and adapt as conditions change. Hard resilience measures, such as constructing embankments or coastal levies, are – as the experience of Hurricane Katrina demonstrated – often subject to catastrophic failure when conditions exceed design parameters. Furthermore they can reduce social awareness of risk and thereby encourage behaviours – such as the settlement of populations in areas protected by flood control measures – that ultimately increase vulnerability. In contrast, strategies based on soft resilience, by increasing the ability of society to live with variability, risk and change, may ultimately prove more effective than the hard resilience approach. The shared learning dialogue methodologies being developed as part of our on-going programme have proved useful in identifying key points of entry for

developing soft resilience and both the advantages and limitations of hard resilience.

5. **Working with pulsed change.** In all the case study areas under our programme extreme events have served as a major catalyst for change. In Tamilnadu, the impact of the Asian tsunami raised policy awareness about coastal issues and continues to generate basic interest in strategies to address coastal problems. In the Nepal Tarai, Uttar Pradesh and Bihar the long history of flooding is the primary catalyst for livelihood strategies to mitigate risks at the community level. Finally, in the Pakistan cases, earlier disasters served as the catalysts for formulating the risk reduction programmes currently in use. In the Lai Basin (Muzaffarabad), these programmes are hazard specific and involve both difficult-to-maintain interventions such as a flood early-warning system installed by Japan International Cooperation Agency (JICA) as well as proposed structural measures. In Muzaffarabad, all new houses funded under post-earthquake reconstruction programmes are required to use one of two standardised designs. While case information from the region suggests that this may not directly reduce risk and is unlikely to be effective or sustainable, the earthquake disaster did catalyse a massive expansion in communication capabilities, transport, banking and other systems. Though not formally recognised as contributing to climate and other disaster risk reduction, these developments are more basic systemic changes that will probably reduce the vulnerability of regional populations to all natural hazards. In general, identifying strategies for working with the windows of opportunity created by a disaster is important.

6. **Refining understanding of the use and limitations of information on climate and other hazards.** Changing the mental maps that sector specialists, decision-makers and individual users bring to climate and hazard projections is perhaps the greatest challenge for shared learning. Disciplines such as hydrology and engineering rely on projections of future conditions (such as flood flows) as being as precise as possible in order to design structures. Design principles for soft resilience in contexts characterised by uncertainty and variability are rarely taught, but knowledge of such principles is exactly what responding to climate change and other natural hazards often requires. We need a better understanding of the way different types of information on gradual but relatively assured processes (for example, the gradual rise in sea-levels projected) and probabilistic risks (like storm frequencies and intensities) can be used. Our understanding improved, we need effective strategies of communicating these different types of information.

7. **Improving governance of the change and adaptation process.** Processes for responding to disaster risks and adapting to climate change will involve numerous questions of equity and will affect the lives and livelihoods of many groups. Pluralistic approaches that enable different populations to give voice to their concerns and perspectives and that enable them to take action as systems change are, as a result, essential.

Design principles for soft resilience in contexts characterised by uncertainty and variability are rarely taught.

Key Insights

Initial results emerging from the case studies and other activities of our project have generated insights regarding potential points of entry for both specific approaches to climate change adaptation and disaster risk reduction and the methodologies useful to inform these processes.

Over the long-term, supporting the development of systems that help diversify risks and support adaptive capacity may be as – or, in many cases far more – cost effective than courses of action targeted at specific risks.

Direct Versus Systemic Points of Entry for Supporting Disaster Risk Reduction and Adaptation

Most policy dialogue and implementation activities related to disaster risk reduction and climate adaptation focus on activities that can be *directly* related to specific hazards. Such strategies involve activities such as the creation of hazard-specific early warning systems, building disaster response capabilities at the community and other levels and the strengthening of physical structures. The sustainability of many such interventions is questionable because the operational business models on which they are based are unclear.

The adaptive capacity of populations depends as much on the nature of underlying systems of communication, transport, organisation, knowledge management, finance, governance and livelihoods as it does on interventions that are specifically designed to respond to climate risks. As the Muzaffarabad case study illustrates, underlying systems are often expanding in ways that support adaptive capacity and reduce future risks, but their contribution is rarely recognised as a formal part of risk reduction by policy and development actors. This case study also illustrates the key role disaster can play in creating a window of opportunity for systemic changes. Risk reduction in Muzaffarabad is occurring as much through indirect and unintended changes catalysed by the earthquake as it is through the direct interventions of private sector, non-government and governmental organisations. Furthermore, many of the systemic changes, such as the expansion of communication systems, are occurring not through development support but based on private sector business models. *Recognising the points of entry for supporting risk management through changes at the level of systems and bringing those to the centre of policy dialogue is, we believe, essential.* Not every disaster, however,offers the same window of opportunity for bringing about systemic changes. Often this window rapidly closes as social, political and other kinds of routine processes begin to dominate in the aftermath of the disaster.

Over the long-term, supporting the development of systems that help diversify risks and support adaptive capacity may be as – or, in many cases far more – cost effective than courses of action targeted at specific risks. As discussed in the overview chapter to follow, interventions at the level of systems that support adaptation to risk and climate change will often have

different cost and benefit structures than those of approaches more narrowly targeted at direct risks. Multi-function systems, such as those for communication, banking, transport and education, generally operate on the basis of private or public sector business models. Interventions that strengthen such systems and link hazard specific interventions to them are likely to be much more cost effective and sustainable than stand-alone risk reduction interventions.

Techniques such as the matrices presented in the next chapter as well as those in each case study that map ongoing interventions in relation to both direct risks and underlying systems can serve as a basis for clarifying the intervention strategies proposed.

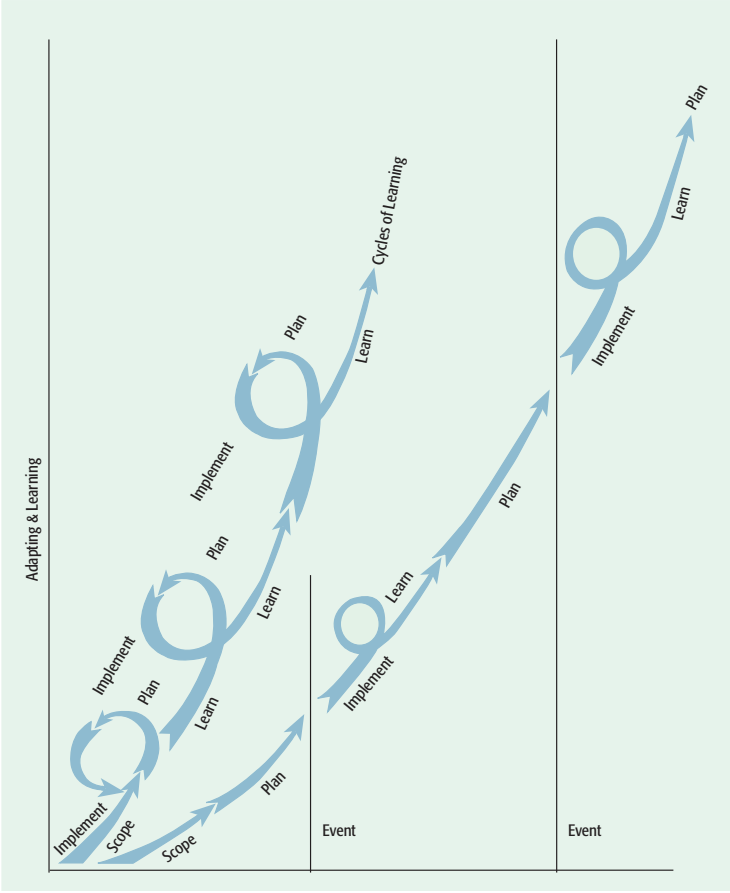
Methods for Shared Learning

The programme has developed an intensive dialogue process designed to catalyse shared learning across scales, sectors and communities. This shared learning process is outlined in the diagram to the right. Experiences emerging from the initial implementation of these shared learning dialogue methodologies indicate that capacity development and sustained processes are crucial for them to be effective. In particular, shared learning requires an iterative process in which the capacity of facilitators to translate knowledge among contexts is essential. Key capacities required in order to implement it include:

- Interdisciplinary understanding of core topics including both the technical dimensions of climate change and hazard relationships as well as community and stakeholder processes;
- Facilitators' ability and capacity to learn and understand as opposed to allowing their own perspectives to dominate either the dialogue or its interpretation; and
- Effective systems for capturing, recording and responding to knowledge as it evolves in the dialogue process.

Shared learning dialogue processes can be facilitated by, but should not be confused with, analytical approaches such as capacity-vulnerability analysis. Techniques that support shared learning include strategy ranking methods, cost-benefit analysis and strategy mapping.

Shared learning process

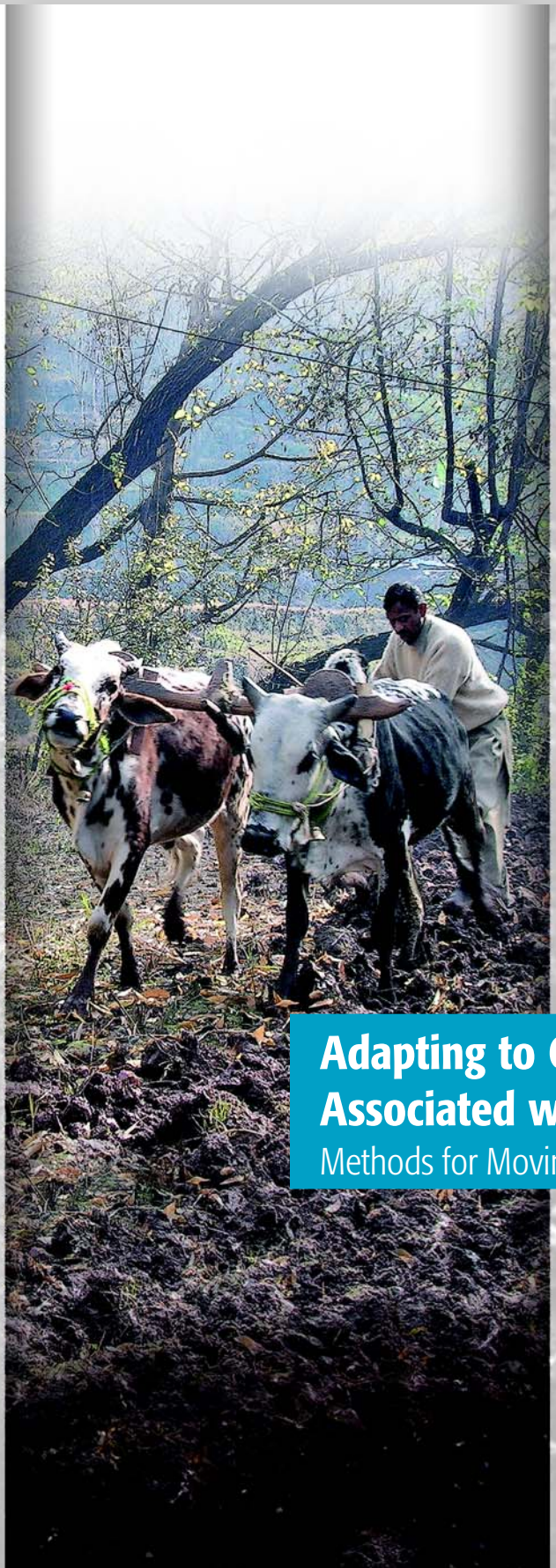


Ways Forward

Communication between levels, sectors and communities, the basis for shared learning, can only be developed through effective dialogue processes.

This report presents preliminary insights from work in progress. Though the perspectives of the authors will continue to evolve, the key elements of a way forward are clear. Reducing the risk of disaster and responding to the challenges inherent in a changing climate will require four steps:

1. **Innovation:** The development of strategies for risk reduction and adaptation that strengthen the capacity and resilience of underlying systems as well as more risk-focused approaches.
2. **Incubation:** The development, testing and evolution of diverse approaches that contribute to risk reduction and adaptive capacity and, more importantly, *the operational business models through which they can be sustained.*
3. **Documentation and analysis:** Without this there will be little basis for the shared learning process needed to drive adaptation and risk reduction over the long term when global society must respond to climate and other hazards.
4. **Dialogue:** Communication between levels, sectors and communities, the basis for shared learning, can only be developed through effective dialogue processes. Shared learning dialogue techniques can also play a key role in monitoring and evaluating the effectiveness of risk reduction and adaptation support measures.



CHAPTER 2

Adapting to Climate Change and the Risks Associated with other Natural Hazards:

Methods for Moving from Concepts to Action

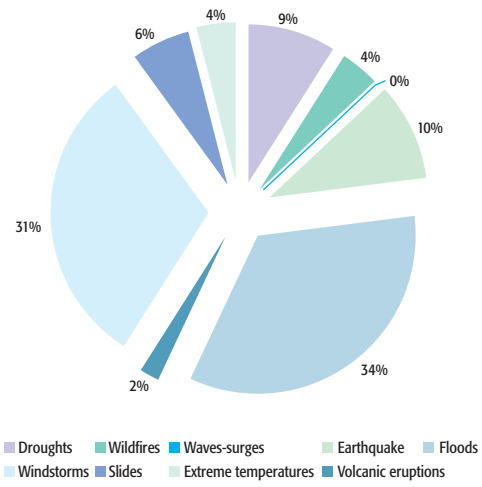
Marcus Moench

The Challenge

In many cases, risk reduction cannot be achieved through structural measures and societies need to develop social systems and adaptive capacities that enable populations to live with risk.

Climate change is increasingly recognised as among the greatest challenges human society will face over the coming century. While it will affect everything from basic ecosystem processes to the spread of disease, some of the greatest impacts are anticipated to occur due to increases in the frequency and intensity of extreme climate events, i.e. storms, floods, droughts. In total, between 1974 and 2003, preliminary data from 6,384 events show that windstorms, droughts, extreme temperatures, floods and wave surges accounted for 75% of natural disasters (Hoyois and Guha-Sapir, 2004). Extreme weather events already account for over 70% of recorded disasters and are known to have a disproportionate impact on poor communities. If one adds in landslides and wildfires – both of which could be affected, though less directly, by climate change, the percentage of climate related disaster deaths increases to nearly 85% (EM-DAT data cited in Dilley, Chen *et al.*, 2005). The recurrent losses due to such extreme events have, in fact, been identified as a major factor contributing to endemic poverty (Benson and Clay, 2002; ISDR, 2004; Wisner, Blaikie *et al.*, 2004; IRIN, 2005). Furthermore, the incidence and economic impact of climate related disasters has been increasing over recent decades (World Meteorological Organisation, Co-operative Programme on Water and Climate *et al.*, 2006). As the Hyogo framework for Disaster Risk Reduction highlights, disaster risk reduction is essential if the world is to succeed in reaching the Millennium Development Goals (ISDR, 2005). In many cases, risk reduction cannot be achieved only through structural measures and societies need to develop social systems and adaptive capacities that enable populations to live with risk. This involves, in essence, largely similar sets of capacities as those required for adapting to climatic variability and change. Strategies for responding to climate change, reducing disaster risk and alleviating poverty are, as a result, inherently intertwined.

World distributions of natural disasters: (6,384 disasters)



At a global level some of the consequences of climate change – increases in average temperature, changes in the frequency and intensity of extreme weather events, changes in sea-level, etc. – are relatively well understood. What such changes actually mean for local areas is,

however, far less so. At this level, a myriad of factors come into play. Economic and livelihood systems, transport, communications, land-use patterns, formal and informal mechanisms for risk sharing, cultural values, etc. all play a major role in shaping *who* will be affected by climate change and *how* they will be affected. The impacts, although heavily shaped by global systems, are thus inherently local. As with impacts, options for adapting to climate change – or indeed the risks posed by any natural hazard – are inherently location specific but are shaped by economic, climatic, water resource and other systems that operate at regional to global levels.

The fact that climate and other risks are location specific, but that the options for responding to them depend heavily on regional to global systems, presents a methodological challenge for entities seeking to understand and support risk mitigation or adaptation. In most situations, local knowledge, the foundation of community-based risk reduction strategies, only partially reflects the opportunities and constraints emerging at higher levels. The case of early warning systems illustrates this well. A decade ago, in the mid 1990s, cell phone technology was accessible only to wealthy urban households in countries of South Asia. Now it is ubiquitous even in distant rural areas and, in addition to its core communication function, is being tested as a mechanism to disseminate disaster warnings. Access to this type of communication and early warning system – to say nothing of the behavioural changes it could enable – was until recently unthinkable for individuals in rural communities. Now it is a central feature in attempts to reduce risk and support adaptation. Similar fundamental shifts in economic systems, demographics, transport, environmental conditions, government policies, and so on are contributing to the reshaping of livelihood systems and climate / hazard vulnerability across South Asia. Communities experience the local effects of such shifts but are often too embedded in their context to envision the opportunities and constraints the shifts will create over time. As a result, strategies for disaster risk reduction and adaptation require the integration of local, community-based, knowledge with knowledge of higher-level changes in policies, economic systems, technologies, environmental systems, and a myriad of other factors. Achieving this integration represents a major challenge.

The challenge is further complicated by the cross-sectoral nature of risk and adaptation issues and the 'pulsed' nature of change processes (Gunderson and Holling, 2002). Where the cross-sectoral aspect is concerned, adaptation and disaster risk reduction do not map neatly onto sector based organisations, such as those that exist in most countries for water management or urban planning. Instead, risk reduction and adaptation are inherently interdisciplinary topics and will require changes or action across multiple sectors. As a result, they are not 'natural' focal points for projects or other types of action. Furthermore, many of the most effective avenues for supporting adaptation and risk reduction are only tangentially linked to the specific impacts associated with climate change or natural hazards. Recent research in India and Nepal, for example, highlights the role that

Communities experience the local effects of change processes but are often too embedded in their context to envision the opportunities and constraints the changes will create over time.

Peri urbanisation in Pakistan.

Socially and politically, pressure for change often rises during and immediately following crises.

income diversification plays in reducing climate risks, particularly in areas that are heavily dependent on agriculture (Moench and Dixit, 2004). Over the long term, educational levels are a central factor influencing the ability of populations to diversify. It is difficult, however, to argue that general education programmes should form a central element in strategies for climate adaptation and disaster risk reduction – the link with exposure to extreme climatic events is, at best, tangential. This said, when viewed from a systemic perspective support for general education as the foundation for diversification may, in actuality, be central to any strategy for climate adaptation and disaster risk reduction.

Finally, the pulsed nature of change processes is a major complicating factor. Socially and politically, pressure for change often rises during and immediately following crises. This window of opportunity, however, dissipates rapidly as time passes and other issues take centre stage. Most development planners and other actors focus on incremental processes of change – the gradual development of infrastructure, social capital, institutions and policy frameworks. Pressures for fundamental change, however, often emerge suddenly and then dissipate. This disjuncture between societal approaches and the nature of change processes is of particular relevance in the case of natural hazards and climate change. Events that are now classified as 'extreme' may become the norm. Reducing risk may, as a result, depend on societies' ability to recognise longer-term change processes and take advantage of the brief windows of opportunity for bringing about fundamental change following crises. The case of Hurricane Katrina illustrates the issue well. The U.S. Gulf Coast is extremely vulnerable to sea-level rise, particularly if that is accompanied by increases in the frequency or intensity of hurricanes. Ideally, the process of reconstruction following Katrina would take this vulnerability into account through fundamental changes in, for example, land-use and water management systems (Moench and Stapleton, 2007). Unfortunately, although more radical changes have been discussed, most reconstruction activities emphasise replacement of pre-existing infrastructure and livelihood systems. Rather than moving settlements to higher ground away from the coast, for example, most investments are going into strengthening or raising existing levies. However unsustainable current conditions may be, post-disaster reconstruction efforts generally focus on replacement of pre-disaster

infrastructure, livelihoods, organizations and procedures rather than replacement these more sustainable systems.

Adaptation to climate risk, particularly the hazards associated with extreme events, will require basic changes in approaches to disaster risk reduction. Effective mechanisms will need to be found for implementing courses of action across sectors and between communities and higher levels of organisation. Perhaps more importantly, effective strategies will need to be developed that shape local and regional development pathways in ways that reduce or avoid climate risks. In many regions this may need to 'go beyond' the incorporation of risk reduction measures in standard development programmes. Little long-term benefit may, for example, be achieved by improving coastal storm defenses as part of a regional development programme if sea-level rise threatens the entire coastal region. In this case, alternative development pathways that either focus on the construction of major assets on higher lands or change the design of assets in ways that accommodate sea-level rise (scientists in the Netherlands are, for example, proposing the development of 'hydrometropols' – modern Venices) will be essential (Kabat, Vierssen *et al.*, 2005). Radical changes of this sort may, in some cases, only be possible when existing infrastructure in vulnerable regions has been disrupted and there is widespread acceptance of fundamental change. Such conditions are perhaps most likely when extreme storms or other similar events create windows of political and social opportunity for change. As a result, mechanisms for anticipating and working with the windows of opportunity for fundamental change that exist following crises will also be essential. However complicated it may be — and existing experience documented by ProVention (see http://www.proventionconsortium.org/?pageid=32&projectid=10) with attempts to incorporate risk reduction in reconstruction programmes does highlight the constraints faced — we argue here that the post-disaster period does represent a critical window of opportunity for interventions to reduce risk over the longer term. Just as incorporation of risk reduction in development programmes is increasingly recognized as a major challenge for the development community, we argue that incorporation of risk reduction in reconstruction is an equally important challenge for the communities of actors involved in reconstruction.

Adaptation to climate risk, particularly the hazards associated with extreme events, will require basic changes in approaches to disaster risk reduction.

Objectives

The objective of this publication is *first* to outline core conceptual elements that structure understanding of adaptation processes and their relationships to disaster risk reduction, *second* to discuss the implications of these concepts for approaches to investing in adaptation and disaster risk reduction, and *third* to identify practical techniques for moving from concepts to courses of action that support climate adaptation and disaster risk reduction.

Conceptual Foundations

Focusing on the factors that enable or constrain people to respond to the challenges faced in a particular situation creates a link between concepts and what can practically be done.

Philosophically, the starting point for all our work on adaptation is founded on systems theory. We view the challenges of responding to climate risk as being shaped by the complex interaction between dynamic natural, social, economic, cultural and political systems. These dynamics are, due to their complexity, dependence on initial conditions and non-linearity, inherently chaotic and difficult to predict. Surprise is, as a result, inevitable. Consequently, attempts to develop 'integrated' approaches that respond to all the potential consequences and dynamic changes in human and natural systems will be ineffective and are inherently inappropriate (Holling and Meffe, 1996). Instead, as a growing body of literature now recognises, approaches need to be founded on an understanding of systems – broad perspectives that recognise the complex interplay between diverse human and natural systems (Gunderson 1999; Holling, 2001; Gunderson and Holling, 2002).[1] Solutions to emerging problems will be clumsy, constructed on the basis of partial measures that are targeted toward key factors that constrain or enable humans to adapt to conditions as they emerge within the continuous process of change. It is this focus on the factors that *enable* or *constrain* people to respond to the challenges faced in a particular situation that creates a practical linkage between the concepts discussed below and what can practically be done. This is important to keep in mind as basic conceptual elements are discussed below.

Adaptation

At a conceptual level, adaptation in human systems can be thought of as driven by two core processes: *selective pressures* (the equivalent of natural selection in ecosystems) and what might be termed *agency-driven innovation* (that is, proactive forms of innovation or action in response to perceived constraints and opportunities). These two processes are not separate; they interact as agents experience selective pressures or perceive opportunities and most commonly act pro-actively or 'adapt' within the limits of their capacities, perceptions and priorities.

The role of selective pressures has been a central pillar in evolutionary theories and has served as a cornerstone of modern biology since Charles Darwin published *The Origin of the Species*. In biology it has been defined as: 'the process whereby organisms better adapted to their environment tend to survive and produce more offspring.'[2] Organisms having characteristics that are favourable or give them comparative advantages in relation to other organisms (whether of the same species or different species) survive and reproduce better than organisms lacking such characteristics or having other

[1] See also www.resalliance.org

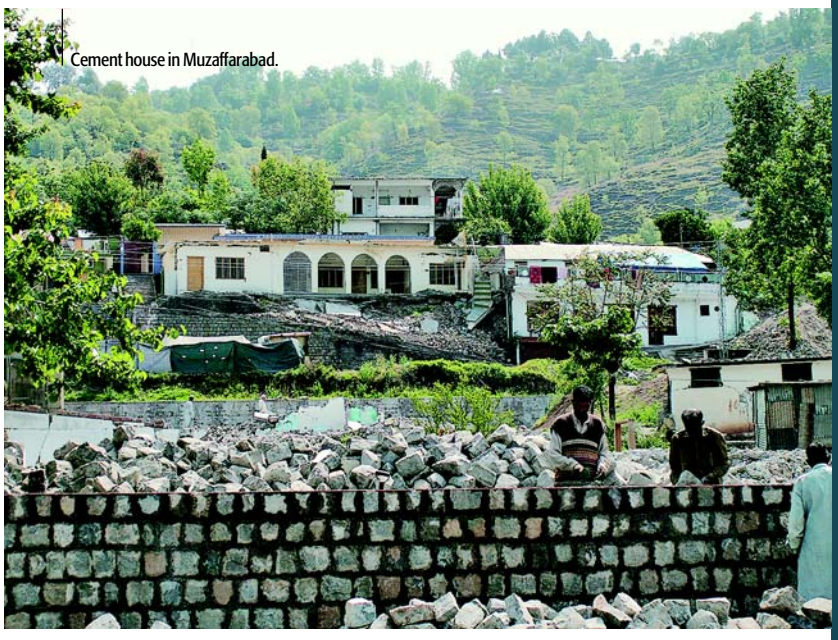
[2] The Oxford Pocket Dictionary of Current English 2006, originally published by Oxford University Press 2006.

characteristics that place them at a competitive disadvantage. When such characteristics can be "inherited" (whether genetically or through education across generations), over time advantageous features are propagated and negative features 'sifted out.' As a result, population characteristics evolve in ways that are increasingly adapted to their context.

Concepts of selection apply equally well with regard to many aspects of human systems as they do with regard to biological systems. Basic economic theory, for example, views the selective pressures generated by competitive markets as the major force driving efficiency and innovation. Efficient business models and technologies tend to have a competitive advantage over less efficient ones and thus tend to survive and proliferate. Better educated workers have a comparative advantage over others in competitive job markets, a factor that provides a strong selective pressure supporting education and the gradual evolution of social capital at a societal level.

As in ecosystems, the nature of selective pressures in social systems and the ability of different entities (individuals, households, businesses, etc.) to adapt to them vary greatly. Entities that exist in contexts where key resources (such as financial and intellectual capital) or key inputs (such as labour, energy or water) evolve in ways that maximise their ability to capture, minimise dependency on, or make efficient use of scarce inputs. Often this evolution involves pro-active (agency-driven) courses of action undertaken by individual agents in response to the opportunities and constraints emerging from the selective pressures encountered. When conditions are highly variable, as they are for example in volatile currency markets, specialised mechanisms are developed for managing that variability. In this case, entities (firms) often diversify assets, set prices based on baskets of currency or take other steps that minimise the impact of variability on their core activities. Major challenges emerge when variability exceeds the range commonly encountered in recent history. Just, however, as ecosystems can be drastically reshaped by sudden extreme events (such as intense, extended droughts) so economic and social systems can be reshaped by periods of intense economic or social disruption (such as a war or extended economic downturn). In this case the characteristics that made an entity 'well adapted' to the pre-existing context may contribute to its' demise under the new conditions. Firms, for example, that have adapted to operating in protected markets often lack the characteristics necessary for survival when protective barriers are removed. This is also the case in agricultural and natural

Education is central to adaptation: Better educated workers have a comparative advantage over others in competitive job markets.



© M. Moench

Cement house in Muzaffarabad.

systems. If, for example, exposure to drought is eliminated, people have little incentive to plan for it by implementing efficient water technologies, purchasing insurance or diversifying crops. When this occurs, the 'shock' to an agricultural economic system is likely to be far higher when droughts eventually do occur. Similarly, in the western U.S., decades of effort to reduce forest fires have led to high levels of fuel loading in the forests. Now, when fires occur, they tend to be far larger, far hotter and far more destructive than ever before. Removal or reduction of selective pressures often limits perceptions regarding the underlying risks - and thus limits the ability of agents to take pro-active action.

Regular exposure to variability and risk forces entities to develop and maintain the adaptive mechanisms necessary to adjust when events occur.

Selective pressures also can contribute to the maintenance of resilience. Regular exposure to variability and risk forces entities to develop and maintain the adaptive mechanisms necessary to adjust when events occur (Gunderson and Holling, 2002). When households or businesses are continuously exposed to the selective pressures generated by variability and risk, they are subject to strong immediate incentives for diversification, strategy shifting and learning. These contribute to their flexibility, adaptive capacity and resilience. Such dynamics occur in relation to virtually all risks.

Overall, selective pressures within societies are often seen as one, if not the, major force underlying the continuous adaptation of skills, technologies, institutions, relationships and other forms of social capital to ever-evolving contexts. Such adaptive processes are, it is important to recognise, not always positive in relation to many social objectives – such as poverty alleviation or social equity. Comparative advantages (whether from education, wealth, location or other sources) in competitive contexts often persist across generations and sections of society giving rise to deeply entrenched social, ethnic, class and caste divisions.

Relief camp in Muzaffarabad.

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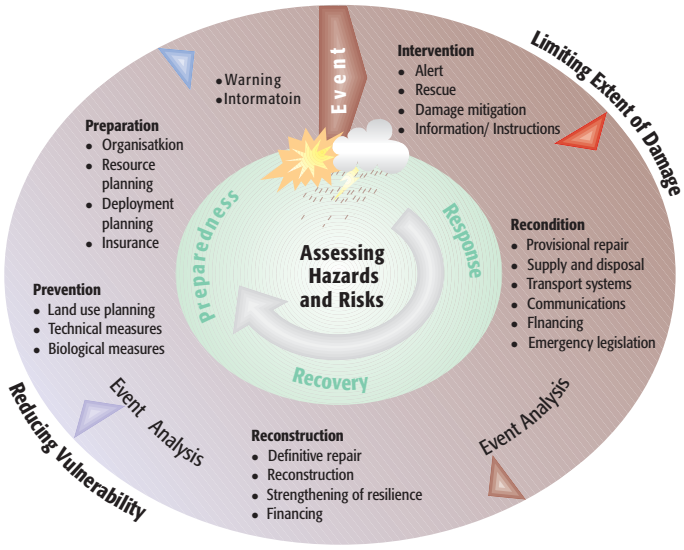
Although selective pressures are a major factor, adaptation in human systems is not driven only by them. Unlike natural systems, actors within human systems strategise and take action in response to aspirations and perceived opportunities. As a result, the concept of *agency* can be seen as a major difference between adaptation processes in human and natural systems. Agency, in the philosophical sense, is the capacity of an individual, group or organization (an "agent") to act. Agency can operate at any level from the individual to the societal. At the individual level, courses of action to improve skills or acquire resources that enable people to take advantage of the opportunities or to respond to the

constraints they perceive represent a form of proactive adaptation. Planning, strategising and the proactive innovation and development of capacities and institutions in response to perceived opportunities and constraints also occurs within organisations such as households, firms, and governments. This type of 'agency-driven innovation' underlies courses of action ranging from investments in education, livelihood diversification and migration at the individual and household level (the so called 'autonomous forms of adaptation') up to programmes and adaptation plans implemented by governments or international organisations (so called 'planned adaptation'). It also underlies the responses agents (individuals, households, organizations, etc.) make in relation to sudden pressures encountered during disasters.

As with adaptation in response to selective pressures, *agency-driven* forms of adaptation depend heavily on exposure to and familiarity with sources of risk or opportunity. Perceptions catalyse responses to both opportunities and risks. If people have never been exposed to specific conditions, their ability to perceive and respond to a potential opportunity or threat is likely to be limited. When the threat or opportunity is obvious, responses are much more likely to follow. As a result, as with selective pressures, the frequency of events and the degree to which people are exposed to them has a major influence on proactive adaptation. When changes or fluctuations are infrequent and sudden, then the ability to perceive (and take seriously) both the opportunities and risks associated with them is limited and thus so is the ability



Source: Swiss Civil Protection

to take proactive steps to adapt. In this situation, a prime 'window of opportunity' for reducing future risks may exist in the immediate aftermath of disasters when awareness is high and existing entrenched systems are disrupted. In nature, adaptive processes often operate in pulses of rapid change followed by slower periods of more linear growth and refinement. This is also the case in social systems. It is a major point where adaptation processes link with our next topic – disaster risk reduction.

A prime 'window of opportunity' for reducing future risks may exist in the immediate aftermath of disasters when awareness is high and existing entrenched systems are disrupted.

Disaster Risk Reduction

Conceptually, reducing the risk of disasters is closely associated to adaptation processes. The Swiss disaster preparation cycle, a fairly conventional approach to DRR, characterises preparation as part of a continuous cycle of activities which move from disaster events through recovery (damage limitation) and risk reduction (preparation) phases until the next event occurs. Many of the elements

identified in this cycle – strengthening of resilience, land-use and other planning, insurance and the development of early warning information – should reduce vulnerability to the next event and thus, in essence, assist regions in 'adapting to' the types of events that can cause disaster.

The contribution DRR measures of the type envisioned in the Swiss disaster preparation cycle can make to adaptation is, however, partial. In most disaster preparation contexts, resilience is largely discussed in relation to strengthening of physical structures, not in relation to the underlying systems and sets of capacities that enable societies to adapt to variable and changing conditions. Other measures such as land use planning, insurance, warning and information are also only partial steps toward adaptation.

Measures such as land use planning, insurance, warning and information are only partial steps toward adaptation.

Wider approaches to the conceptualisation of disaster vulnerability, such as those developed by Ben Wisner and others in their classic book *At Risk* are, however, much more closely linked to concepts of adaptation (Wisner, Blaikie *et al.*, 2004). In specific, the Disaster Pressure and Release (PAR) model focuses on the connections between the progression of vulnerability, disaster and hazards. It defines the progression of vulnerability in relation to *root causes* (limited access to power, structures and resources and ideologies – political and economic systems), *dynamic pressures* (lack of institutions, training, skills, etc. and

Peri urban Kathmandu.

macro-forces such as urbanisation, population growth, etc…) and *unsafe conditions* (physical environment, local economy, social relations and public actions and institutions). Hazards are physical events such as earthquakes, floods and so on. They analyse the links between hazards and the progression of vulnerability – that is the 'disaster' component of the PAR model – using a separate dynamic framework which they term the 'Access' model. The access model 'focuses on the way unsafe conditions arise in relation to the economic and political processes that allocate assets, income and other resources in a society.' (Wisner, Blaikie *et al.*, 2004 p. 92). Access is further defined as involving 'the ability of an individual, family, group, class or community to use resources which are directly required to secure a livelihood in normal, pre-disaster times, and their ability to adapt to new and threatening conditions.' (Wisner, Blaikie *et al.*, 2004 p.94). Individuals and other entities which have access to key resources are seen as much better positioned to cope with the range of hazards that can cause disaster – with 'coping' defined as 'the manner in which people act within the limits of existing resources and range of expectations to achieve various ends.' (Wisner, Blaikie *et al.*, 2004 p. 113).

This wider conceptualisation of vulnerability and the links between social conditions and hazards is used as a basis for identifying a very wide range of potential points of leverage or courses of action that could be used to reduce disaster risk. These points of leverage include many that focus on addressing root causes, dynamic pressures and unsafe conditions – that is reversing the factors in the PAR model that create vulnerability as part of post disaster recovery and sustainable development programmes. This is, in essence, very similar conceptually to the types of activity that are involved in adaptation. Individuals, households, organisations and other entities are seen as 'adapting' by responding to the opportunities and constraints in their environment.

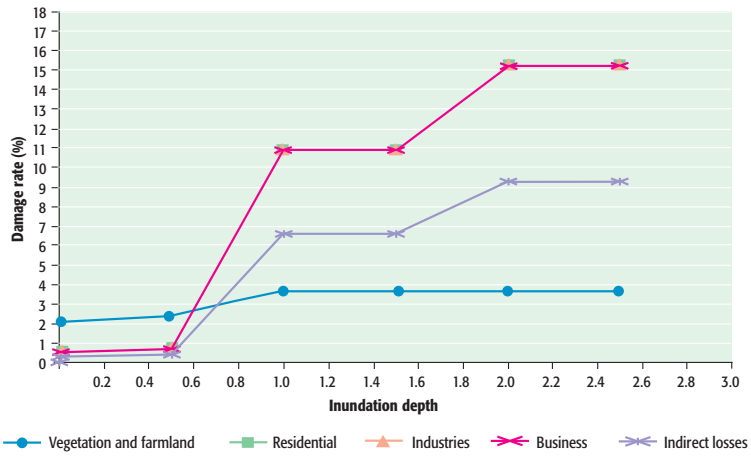
Fragility

In the disaster risk reduction community, the concept of fragility is used to define the relationship between damage and hazard intensity. As fragility increases, damage for a given intensity hazard event increases. As illustrated in the accompanying diagram (for flooding in Semarang, Indonesia) fragility functions are used to identify changes in direct and indirect losses to different classes of assets or activities in relation to flood depth, earthquake intensity and so on (Mechler, 2005).

As fragility increases, damage for a given intensity hazard event increases.

Disaster risk reduction interventions, particularly those focused on physical infrastructure and assets such as buildings, often focus on reducing

Fragility function for direct and indirect flood damages in Semarang



fragility. This is, for example, the case with incorporating earthquake strengthening into building codes or raising river levies to contain higher flood levels. In many cases the goal is to ensure structures or the assets they protect suffer minimal or no damage in events with a specific magnitude. When design events are exceeded, such as when levies or dams fail, the result is often catastrophic. In other cases, however, structures are designed to allow controlled failure and partial protection as the magnitude of events increases. This would be the case, for example, when low-level levies are used to protect agricultural lands with higher levies for urban areas. Often in such cases, lower level levies breach during large flood events and reduce pressure on levies protecting more valuable assets. Under these conditions, asset losses are often step functions with distinct breaks at different event magnitudes.

When design events are exceeded, such as when levies or dams fail, the result is often catastrophic.

Resilience – Hard and Soft Concepts

Concepts of resilience take two broad forms:

1. The direct strength of structures or institutions when placed under pressure – an attribute we refer to as **hard resilience**; and
2. The ability of systems to absorb and recover from the impact of disruptive events without fundamental changes in function or structure – an attribute we refer to as **soft resilience**.

In the disaster context, resilience is often treated as the simple inverse of fragility. Engineers, for example, often refer to increasing the resilience of a structure through specific strengthening measures to reduce their probability of collapse with respect, for example, to earthquake intensities, wind loading or other physical stresses. As resilience increases, the degree of damage for a given intensity hazard decreases. Such approaches fall largely under what we term strengthening the hard resilience. More nuanced concepts of what we would call *soft resilience* are, however, well established in scientific communities working on systems dynamics. The *Resilience Alliance*, one of the main forums for discussion within these communities, defines resilience in the following manner:

'Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience in social systems has the added capacity of humans to anticipate and plan for the future. Humans are part of the natural world. We depend on ecological systems for our survival and we continuously impact the ecosystems in which we live from the local to global scale. Resilience is a property of these linked social-ecological systems (SES). "'Resilience' as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:

- The amount of change the system can undergo and still retain the same controls on function and structure
- The degree to which the system is capable of self-organisation
- The ability to build and increase the capacity for learning and adaptation."[3]

[3] http://www.resalliance.org/576.php accessed on 4/12/07.

Encroached river channel.

Under the above concept, rather than simply strengthening structures or institutions in relation to specific stresses (adding cement, etc.), soft resilience attributes depend on the flexibility and adaptive capacity of the system as a whole. Practically, our prior research in South Asia (Moench and Dixit, 2004) indicates that resilience and adaptive capacity in communities depends on:

a. Flexibility (within livelihood systems, economic systems, water management systems, institutional systems)
b. Diversification (multiple independent income flows to livelihood systems)
c. The ability to learn from events (at both individual and institutional levels)
d. Education (the knowledge base required to develop new systems when existing ones are disrupted).
e. Mobility (an attribute of flexibility)
f. Risk pooling and spreading (institutional arrangements or other mechanisms for spreading and pooling the impacts of disruptions on the system as a whole);
g. Operational techniques for risk reduction before and following disruptions (techniques for directing the reorganisation process so that growth and conservation phases do not increase rigidity and ultimate vulnerability).
h. Convertible assets (the ability to convert assets accumulated during periods of growth into other forms when disruptions occur)

All of the above contribute to system resilience – that is the ability to adjust to shocks and variability without fundamental changes in overall system structure.

More nuanced concepts of what we would call *soft resilience* are well established in scientific communities working on systems dynamics.

Investing in Change – What do Concepts Mean for Strategy?

We believe investments in risk reduction and adaptation are likely to have high benefits in relation to costs.

The conceptual foundations for understanding adaptation, disaster risk reduction, fragility and resilience have a wide variety of implications for organisations of any type that are seeking to develop a sound basis for investments to reduce risks and encourage adaptation. While full discussion of this is beyond the scope of this paper – and is indeed an evolving field where many elements remain to be developed – some basic principles can be identified at this point. Here we'll address two major areas: (1) the factors influencing the costs and benefits of risk reduction and adaptation strategies; and (2) determining strategic points of entry for change.

Costs and Benefits of Investing in DRR and Adaptation

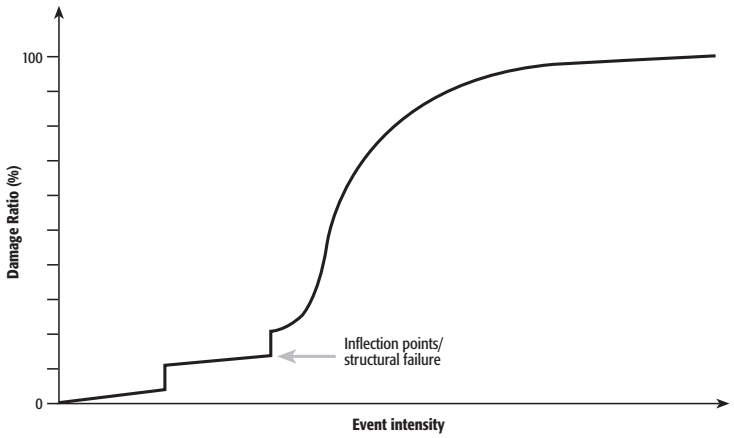
There is an emerging body of work that documents the financial benefits and frequently large benefit / cost ratios associated with disaster risk reduction (FEMA, 1997; Uddin, 2002; Benson and Twigg, 2004; Department for International Development, 2005; Donga and Mechler, 2005; MMC, 2005; Bouwer and Aerts, 2006; Messner, Penning-Rowsell *et al.*, 2006; Benson, 2007; Mechler, 2005). This literature does not, however, generally emphasise differences between strategies for risk reduction. Instead it focuses on evaluation of specific individual investments in specific locations. On a more generic level, we believe investments in risk reduction and adaptation are likely to have high benefits in relation to costs when:

- *They address multiple hazards and serve multiple purposes* (rather than being tied to one specific hazard or use). Early warning systems, for example, are much more likely to be economically viable when they are part of multi-function communication systems and can provide warning of any hazard;
- *They are embedded in development activities and are supported by sustainable public or private sector business models*. When cyclone shelters are built as multi-function public buildings such as schools, for example, the sustaining business model is education (with taxes or fees supporting services and the maintenance of facilities to meet specific day-to-day demands).
- *They have low sensitivity to core assumptions and uncertainties*. Physical structures that are designed to operate within very specific hydrological tolerance ranges (flows, sediment loads, etc.) are, for example, very sensitive if changes in climate are likely to exceed those ranges. Similarly, institutional arrangements that depend on very specific assumptions (such as insurance programmes that are designed on the basis of historical weather losses) may be highly sensitive if assumptions are violated. This point is elaborated on further below.

- *They do not involve major distributional issues.* In many cases, actions that reduce exposure to climate risks for one group or set of assets, increase risks for other groups. This is, for example, the classic case with flood embankment systems. Those outside the embankments largely benefit while those inside are subject to much more intense flooding. Furthermore, each time an embankment is strengthened in one location, the potential for breeching in other (now comparatively weaker) locations increases. Issues of fairness and the operational difficulties of compensating losers aside, when major distributional issues exist, the costs of compensating losers are often underestimated.

- *They do not create new patterns of vulnerability while alleviating existing risks.* Again, the case of levies and embankments provides a classic example. Levies around New Orleans encouraged settlement of low-lying and highly flood-prone areas. When Hurricane Katrina occurred, the resulting damages were far higher than would have been the case if development had not been enabled in these low-lying areas. This type of issue is inherent in many conventional DRR and climate protection strategies. Providing irrigation as a buffer against drought, for example, is only as reliable as the source of water. Many farmers in Gujarat (India) were impoverished when their wells went dry during the 2000-2002 drought because they had developed an intensive, high-investment, form of agriculture based on the assumption that groundwater was an absolutely secure source (Moench and Dixit, 2004).

FIGURE 1 | Fragility function for direct and indirect flood damages



The factors influencing the economics of investing in risk reduction as part of climate adaptation are illustrated further below.

Conceptually, in natural situations the damage due to climate events and other natural hazards almost always follow a rough logistic curve (Figure 1). Losses are low (and there may even be benefits) with low intensity events. These losses increase at inflection points as various system thresholds are crossed and then probably level off past the point where most of the system assets or attributes have been damaged, disrupted or destroyed.

Risk reduction and adaptation interventions are designed to shift the logistic curve downward and to the right. For a given magnitude event, they are designed to reduce damages (costs) and, if possible, increase benefits. The economic returns from investments in such interventions are represented by the space between the pre-intervention and post-intervention curves (Figure 2)

Conceptually, in natural situations the damage due to climate events and other natural hazards probably almost always follow a logistic curve.

FIGURE 2 | Fragility function with and without DRR

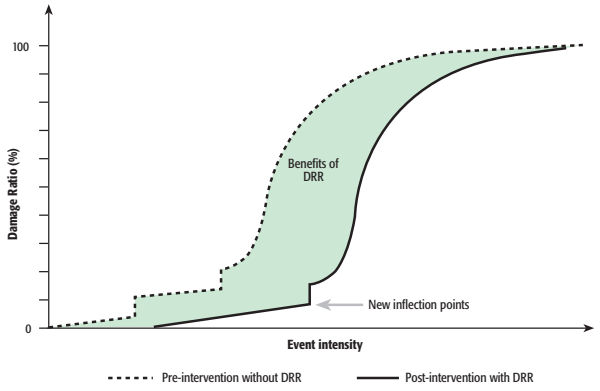
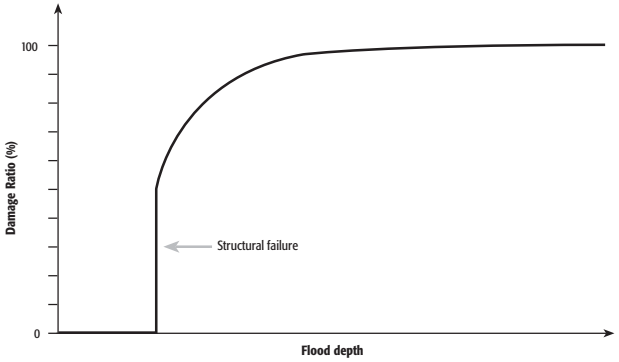


FIGURE 3 | Fragility function, hard resilience (e.g. embankments or dams)



The approaches to risk reduction that depend on hard resiliency tend to provide full protection until they fail – and when they fail it can be catastrophic. This is, for example, the case with protective levies.

Elements Influencing the Costs and Benefits of Hard Resilience

While the above is true in a generic sense, the nature of disaster risk reduction and adaptation strategies have fundamental implications for the shape of the cost and benefit curves and the nature of curves in areas that aren't protected. As previously noted, approaches to risk reduction that depend on hard resiliency tend to provide full protection until they fail – and when they fail it can be catastrophic. This is, for example, the case with protective embankments. Either they keep flood water completely out of an area or they breach and allow flooding (Figure 3).

The curve in Figure 3 illustrates the absolutely critical issue of threshold levels that is inherent in most hard resiliency measures. In order to design a dam or a levy, some knowledge of the magnitude flood and storm flows is essential. This is also the case for low flows. If thresholds are exceeded, then structures fail, whereas below the thresholds protection tends to be complete. Strengthening structures to meet 'any' threshold is often unaffordable. As a result, to determine design thresholds architects and engineers need to have information on the recurrence intervals of specific magnitude events – the '100 year flood' or 'Category 5' hurricane. Obtaining such information and determining its reliability is a particular challenge in the context of climate change.

A more nuanced version of gains and losses from hard resiliency measures, such as embankments, is shown in Figure 4. In the "natural" situation without embankments, low levels of exposure to hazards such as flooding actually create benefits (shaded area "a"). Such benefits from low intensity-short duration floods include groundwater recharge, drainage and the distribution of nutrients and soil. They are eliminated in both protected zones and those where water is concentrated when hard resiliency measures are implemented. This loss of benefits essentially shifts the benefit / damage curve upward in the section shown as "a" in figure 4 relative to natural baseline conditions. In some cases, for example when levies cause water logging, new damages in addition to

FIGURE 4 | Impact area damage curve

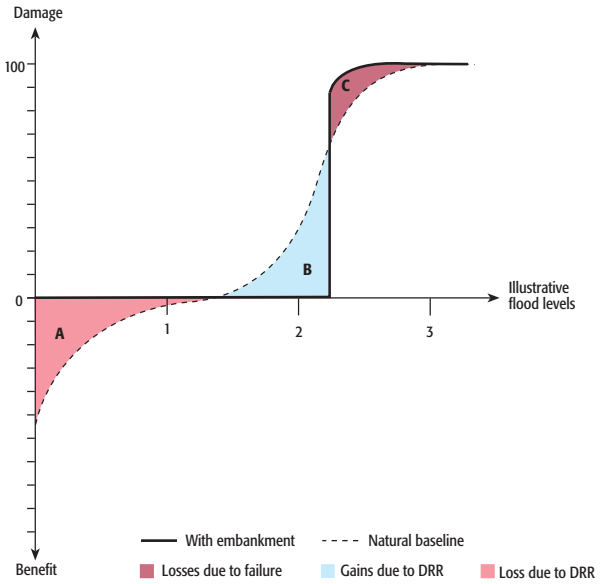
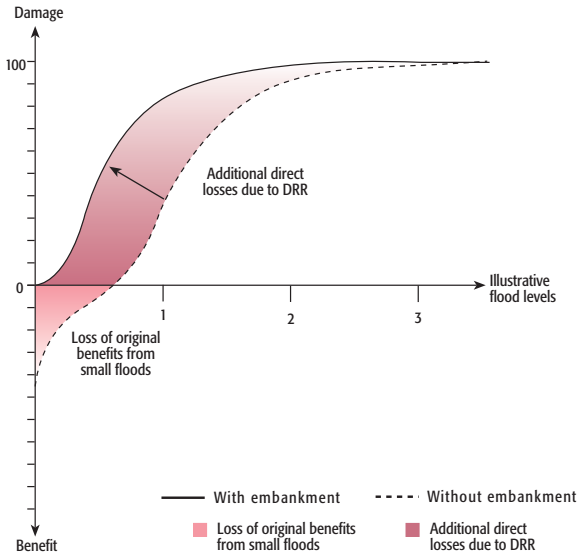


FIGURE 5 | Loss of benefits (areas between embankments)



those in the baseline case are also part of the costs. Losses may also be increased during high magnitude events when protective structures fail. This essentially shifts the upper portion of the damage curve upward and to the left causing the additional losses shown in the "c" section of Figure 4. The actual benefits generated by the protective measures are shown as the "b" section in figure 4. The net benefits from hard protective measures are, as a result, the "b" section minus the "a" and "c" sections of the damage curve.

Figure 5 illustrates the distributional issue that is often present with this type of hard resiliency measure. For areas that are between embankments (as large areas are in some locations such as the Gangetic plains), damages can be increased because flood waters are concentrated in much smaller areas. Populations living between levies lose the amount shown by the shaded area between the 'natural baseline' damage curve and the increased damage curve in Figure 5. This amount would need to be transferred from the economic benefits shown in Figure 4 (again the area marked "b" between the natural baseline damage curve and the new reduced damage curve) as compensation for losses. In addition to the practical difficulties in effecting such a transfer, it represents a reduction in the overall benefits from the DRR or adaptation intervention.

A second feature to note about Figures 4 is the change in the percentages of total asset value at risk for events that exceed the critical threshold that represents levy failure in relation to baseline conditions (area "c"). When hard resiliency measures encourage the concentration of assets in protected areas, then a much larger percentage of assets is at risk if the measures fail. The additional amount at risk is illustrated by the upper shaded area below the 'reduced damage' curve and above the

When hard resiliency measures encourage the concentration of assets in protected areas, then a much larger percentage of assets is at risk if the measures fail.

natural baseline after the critical damage inflection point.

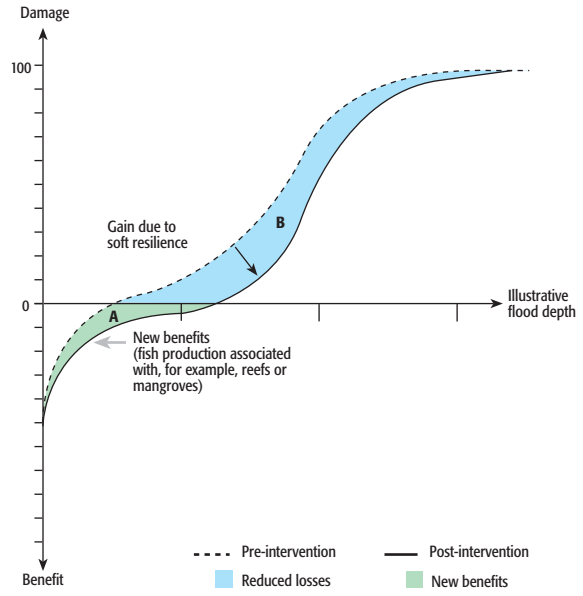
Moving beyond the simplified case of river levies, it is important to recognise that most hard resilience interventions are part of systems that *as a whole* can be designed to fail incrementally rather than catastrophically when critical thresholds are reached. Dams, for example, are designed in ways that allow flood waters to be released rapidly (often resulting in some flooding) when storage capacities are full. Similarly, levies are generally constructed as systems where failure in one section does not result in flooding of an entire protected area. This doesn't reduce the importance of threshold values – but, it changes the nature of the damage curve into a step function with multiple thresholds.

In contrast to hard resilience measures, soft resilience measures alter damage curves relative to natural baselines in ways that do not tend to depend heavily on sharp threshold values.

Elements Influencing the Costs and Benefits of Soft Resilience

In contrast to hard resilience measures, soft resilience measures alter damage curves relative to natural baselines in ways that do not tend to depend heavily on sharp threshold values. Instead, they tend to attenuate the damage curve, moving it down and to the right, as illustrated in Figure 6. They also do not tend to create major 'losers' (such as the individuals owning assets in areas 'between levies') and thus greatly reduce compensation issues. In some cases, soft resiliency measures can create benefits that are in addition to those specifically related to the risk reduction or adaptation objectives. These new benefits add to the value of the intervention as a whole. The examples below involving weather information and the construction of multi-purpose flood buffer ponds illustrate these features.

FIGURE 6 | Gains to soft resilience



Improvements in weather forecasting and communication are often seen as major inputs for reducing the vulnerability of individuals, households to extreme events, such as those anticipated as a consequence of climate change. In this case, the benefits of forecasting accrue through the changes in behaviour catalysed by new information. When storm warnings are provided, the individuals who receive and respond to the information move themselves and their assets out of harm's way or take other protective measures to reduce losses. Individuals who don't receive or don't respond to the information don't gain but, relative to their prior vulnerability levels, neither do they lose. Losses associated with the early warning element of weather information do, however, occur. These primarily take the form of costs incurred when individuals take avoidance behaviour – and then the predicted events don't occur. This is, for example, the case when regions are evacuated in advance of projected storms, but storm paths change and the evacuation ends up being unnecessary. These gains and losses are

illustrated in Figure 7. the damage curve is shifted downward (arrow 1) to a new level by the soft measures but the net gains are reduced when people take avoidance measures against events that don't occur (illustrated by arrow 2 shifting the damage curve back up part of the way to the original baseline).

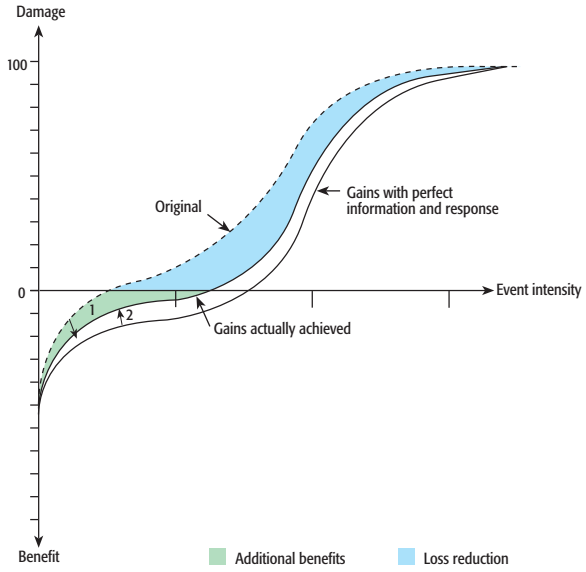
Loss reductions associated with early warning aren't, however, the only benefit from a good weather information system. Provision of high quality weather information enables individuals and many businesses to 'fine tune' their activities in ways that increase productivity. Farmers, for example, often schedule irrigation based on weather projections. This is often critical to increasing yields and reducing pumping or other production costs. Weather forecasts are equally important in other industries such as construction and tourism. These benefits should be accounted as part of the benefits associated with weather information. Similar benefits are also present with many other 'soft resiliency' interventions designed to support adaptation and reduce climate risks. Insurance, for example, is often part of a larger system of credit and banking facilities that generate a wide range of benefits. Economic diversification often generates new sources of income as well as reducing the risks inherent in depending on one source alone. Social networks provide support during crises – but are also major elements giving individuals access to resources, jobs and other benefits. As a result, for low intensity events, the lower portion of the "damage" curve shows benefits other than those achieved through loss reduction.

Soft resiliency forms of infrastructure (infrastructure that is designed to accommodate climatic variability instead of controlling it) can have similar economic attributes as the more institutional and financial measures discussed above. The case of flood retention ponds illustrates this well. Flood retention ponds reduce risk directly by absorbing excess flows. Depending on how they can be operated and managed, however, they can have a number of additional direct benefits. Conceptually these include:

1. Providing groundwater recharge;
2. Serving as water sources for livestock, irrigation and other uses; and
3. Serving as a resource for the development of aquaculture and other 'water-based' livelihood activities.

The above benefits, (illustrated in Figures 6 and 7) add to the direct risk reduction benefits associated with flood protection. They also don't reduce or disrupt existing benefits that are already present as part of the baseline context. Sediment delivery, for example, isn't blocked from areas by flood

FIGURE 7 | Fragility function information example



Economic diversification often generates new sources of income as well as reducing the risks inherent in depending on one source alone.

retention ponds as it is by levies. As a result, the fertility benefits associated with the natural system could be retained. This combination of created and maintained benefits represents, in many ways, the economic benefits of adapting livelihoods to flood-prone environments. Similar benefits could be identified or created in other contexts. In coastal areas which are particularly vulnerable to climate change, for example, the creation of brackish water wetlands and fisheries could accommodate increases in sea-levels and buffer storm effects while also allowing the development of new sources of income.

Interventions designed to respond to the underlying systemic factors limiting adaptive capacity or causing vulnerability are essential.

As with hard resiliency measures, soft resiliency measures would rarely be implemented in isolation. In the Gangetic plain, for example, the development of flood retention ponds could be coupled with activities to raise villages (a traditional method of flood risk reduction in the Gangetic Plain), increase drainage, improve insurance and provide early warning. With this type of portfolio it may be possible to provide equal levels of asset protection as river regulation using dams and embankments would generate with few of the distributional issues – raising one village protects the inhabitants but doesn't adversely affect the inhabitants of other villages. Furthermore, packages that emphasise soft resiliency interventions are far less subject to thresholds. Their viability does not depend heavily on information regarding specific flows or the frequency of floods and storms to be effective and economically viable.

Overall, the economics of investing in disaster risk reduction as part of climate adaptation depend heavily on specifics and the wider network of costs and benefits in addition to those associated with specific reductions in risk. A number of key questions must be evaluated including: *Do measures reduce some benefits relative to baseline conditions? Do they depend heavily on information regarding thresholds – and, if so, is that information available? Do measures have large distributional implications – are there clear losers as well as beneficiaries? Can measures to reduce risk also serve as income generation and adaptation opportunities?* Evaluating the costs and benefits of packages of DRR interventions as part of climate adaptation requires, as a result, a broad economic analysis rather than one that focuses narrowly on damages avoided. It will also in most cases require a mix of hard and soft resiliency interventions.

Identifying Points of Entry

As already noted most contexts the projects and other interventions implemented by governments and other actors to reduce disaster risk focus directly on the proximate causes of disaster and tend to involve measures designed to increase hard resilience. As the above conceptual discussions and some of the best research on risk suggest, however, *underlying systemic factors* are often of greater fundamental importance to adaptation, disaster risk reduction and resilience (Dreze, Sen *et al.*, 1995; Sen, 1999; ISDR, 2004; Wisner, Blaikie *et al.*, 2004). Consequently, interventions designed to respond to the underlying systemic factors limiting adaptive capacity or causing vulnerability are essential. These will often involve 'soft resilience' measures that contribute in fundamental – but generally indirect – ways to adaptive capacity and risk management.

Direct Risk Reduction

Direct measures that appear, at least on the surface, to reduce risk or support adaptation are often relatively easy to identify. They are interventions, in the form of structures, financial mechanisms, communication systems, organisations and so on that can be seen as directly influencing the risk of disasters or supporting adaptive risk reduction. The embankment case discussed extensively in preceding sections is a case in point. The idea of building embankments to keep floods out of vulnerable regions is something most people can intuitively understand. The fact that people often move and settle in 'protected' areas and that this will compound the scale of disasters when embankments breach – as they are ultimately likely to do for a variety of much more complex reasons – is not as easily understood (or if understood, not seriously appreciated). As a result, evaluating the potential unintended indirect consequences of direct risk reduction measures is perhaps *the most important challenge in identifying effective points of entry for direct risk reduction*. The complexity is further compounded by the transitional role measures such as embankments can provide in some situations as long as measures are in place to ensure they do not compound disaster risk. In coastal regions, for example, carefully designed embankments can assist in controlling salinity. While, given projected sea-level rises, this may not be viable on the long-term, in the short-term protection of productive land can generate the resources necessary for transition.

While the process of identifying potential indirect consequences of direct risk reduction measures is complex and often site or case specific, the six criteria bulleted out below can serve as warning flags regarding the viability of a measure:

1. **Low levels of diversification:** Any strategy that relies heavily on one form of intervention or that reduces diversification within systems has a high risk of failure if the assumptions on which that strategy is based prove unreliable.
2. **Heavy dependence on key data and technical assumptions:** If infrastructure is built to withstand a Category 3 storm, the benefits are heavily dependent on whether or not higher intensity storms occur. If interventions are intended to provide interim protection as a basis for transition, then consequences depend heavily on assumptions regarding whether or not such interventions actually contribute to transition or instead compound future vulnerability.
3. **Reliance on narrow assumptions regarding appropriate human incentives and behaviour:** If approaches are framed based on cultural perceptions of what groups (such as rural farmers or fishermen) "should" want and how they "should" live, then projected benefits will not occur if actual behaviors differ in response to the opportunities and constraints such groups face in a given context. This is a particular challenge in the many rapidly urbanizing and globalizing societies where livelihoods have traditionally been based on agriculture or similar activities but incomes and opportunities are increasingly derived from other sources;
4. **Long lead times and high capital investments required:** If the

Any strategy that relies heavily on one form of intervention or that reduces diversification within systems has a high risk of failure.

measures require substantial time and investment to put in place and are intended to repay this through benefits generated over the long-term, then they are heavily dependent on difficult to predict conditions in that future and are especially vulnerable to the impacts of climate change;

5. **Major distributional differences between groups "benefiting" from the intervention and others who bear direct costs:** If there are major "losers" well as as "gainers" from an intervention (whether direct or simply in relation to perceptions of equity) then conflicts can undermine objectives; and
6. **Lack of a clear business model that will ensure risk reduction measures are maintained over the long term, particularly during extended periods when extreme events do not occur:** If the source of funding or other inputs required to sustain an organization or set of infrastructure is unclear during the potentially long gaps between "events" is unclear, then sustainability is highly questionable.

While system level interventions are often difficult to relate directly to risk reduction or climate adaptation, they are often of much more fundamental importance to risk exposure than direct measures.

Systems Level (Indirect)

In addition to interventions that are directly targeted at specific risks, points of entry for reducing risk and supporting adaptation are present within systems. In previous research on responses to floods and droughts, a variety of systemic factors were identified that contribute to livelihood resilience and adaptive capacity (Moench and Dixit, 2004). Adaptive capacity and livelihood resilience depend, in essence, on:

1. *Knowledge systems* – the basic education required to access multiple job and skill markets along with institutional or other forms of memory and learning;
2. *Environmental systems* –the condition of basic land, water and air resources along with the productive ecosystems they support;
3. *Livelihood and economic systems* – the manner in which systems spread risk through diversification combined with their ability to generate surpluses and distribute them in a manner that provides access to the assets all sections of the population require for strategy shifting as well as day to day survival;
4. *Communication systems* – the ability of information to flow in and out of areas, both the technology itself and the institutions and rules governing that flow;
5. *Transport Systems* – the ability of goods, people and resources to flow in and out of areas;
6. *Financial systems* – the ability of funds to flow in and out and for assets to be converted as required;
7. *Organizational systems* – the ability to self-organize following disruption as well as during more linear and controlled phases of change processes; and
8. *Adapted infrastructure systems* – the degree to which physical and institutional structures are designed to accommodate and respond flexibly to climatic variability and change including extreme events.

While interventions at this level are often difficult to relate directly to risk reduction or climate adaptation, they are often of much more fundamental importance than direct risk reduction measures. Direct measures for risk reduction are often of an interim nature – humans respond to the risks they perceive in a given context and, as the

immediacy of that risk perception dissipates the willingness to invest time or other resources in risk reduction will dissipate as well. Adaptive capacity and the ability to respond to risks as they emerge are, as a result, maintained over time more by the functioning of underlying systems than by direct measures.

Adaptive capacity depends at a basic level on the ability to self-organize, respond flexibly, convert assets and shift strategies as risks emerge or during the period following disruptive events. This is, in turn, depends in an absolutely fundamental manner on the presence and functioning of underlying systems. As a result, activities that strengthen such systems and improve access for vulnerable groups to them represent a critical point of entry for supporting risk reduction and adaptive capacity.

It is important to emphasize here that care must be taken in identifying potential points of intervention to reduce risk through interventions at the level of systems. Although the bullets listed above identify what we believe are critical factors that contribute to adaptive capacity and risk reduction in relation to floods, droughts and similar extreme climate events, little actual global experience exists regarding the impact of specific "systems level" interventions to manage climate or other risks. This is a major emerging area where experience, research and further conceptual development are essential. Clearly the role of specific systems in reducing - or increasing risk - depends on the nature of the hazard. Transport systems, the foundation for mobility, clearly play a major role in reducing the livelihood and food security impacts of floods and droughts. At the same time, where communicable diseases are concerned, the increased mobility of populations greatly increases the probability of major global epidemics.

Phasing: Windows of Opportunity
Points of entry for initiating activities to reduce risk or support adaptation depend heavily on timing. In most situations, government and international programmes emphasise the gradual development of capacities as part of on-going development activities. Such contexts, however, tend only to allow incremental change – the refinement of policies, gradual development of economic or institutional systems, the diffusion of new technologies and so on. Fundamental changes, particularly those that disrupt embedded patterns and relationships, are both difficult to envision and undertake when current systems are functioning in a normal manner. Crises precipitate other forms of change.

This dynamic was, cynically but very accurately, captured by P. Sainath in the title and content of his seminal book '*Everybody loves a good drought*' (Sainath, 1996). Crises catalyse behavioural and other changes that would be impossible in 'normal' times. In many cases such changes are ephemeral and dissipate over time – the disaster response community often highlights the manner in which political will and the social urgency for change wither rapidly as relief transitions to reconstruction. The chaos and humanitarian urgency that characterises relief contexts also is not conducive to the development or implementation of strategies that respond to longer-term risks.

Crises catalyse behavioural and other changes that would be impossible in "normal" times.

The above said, however, crises often do catalyse basic changes in conditions and systems. Hurricane Katrina caused the largest migration in the history of the United States since the Civil War of the early 1860s.[4] In contrast to a pre-Katrina population of over 400,000 (484,674 in the 2000 United States census), according to Logan (2006), the full-time population of the city was estimated at only 150,000 in January 2006. Logan further indicates that 'if the future city were limited to the population previously living in zones undamaged by Katrina it would risk losing about 50% of its white residents but more than 80% of its black population' (Logan, 2006, p.16). Following Katrina debates are underway regarding approaches to water and land management throughout the U.S. Gulf region that would have been unthinkable before the inadequacy of existing levy systems was so unequivocally demonstrated. In India the famines and droughts of the 1940s and 1960s provided much of the impetus for both the Green Revolution (which represented a fundamental change in agriculture) and the development of major support programmes (such as the Public Distribution System) that continue to the present. In the Netherlands the highly sophisticated water management systems owe their establishment to disastrous floods and levy failures that occurred in the 1950s. Overall, identifying points of entry for making fundamental changes that reduce disaster risk and support adaptation requires strategies that address and bridge the gap between incremental change processes that characterise most development contexts and those that can occur during the windows of opportunity created by crisis.

The disaster management community has developed relatively broad conceptual definitions for the relief, recovery (damage limitation) and risk reduction (preparation) phases of activity.

In discussing the windows of opportunity for change created by disaster it is extremely important recognize the limitations of existing terminology and the conceptual frameworks different groups of actors use to frame their arenas of action. The disaster management community has developed relatively broad conceptual definitions for the relief, recovery (damage limitation) and risk reduction (preparation) phases of activity. Drawing on these definitions, humanitarian actors have developed specific types of relief, reconstruction and rehabilitation or disaster risk reduction programmes for each of these phases. These programmes are generally separate from the equally broadly conceptualized sector-focused programmes that are part of most national development strategies. When we emphasize the windows of opportunity to reduce risk during the reconstruction process that follows disasters, this does not necessarily imply that DRR activities of the type often promoted by humanitarian organizations can easily be incorporated in reconstruction programmes. Existing experience, in fact, suggests that this may face quite basic challenges - see, for example the array of recovery studies supported by ProVention (http://www.proventionconsortium.org/?pageid=18#rel) and the report of the Tsunami Evaluation Commission (Telford & Cosgrave, 2006). In the case of the Pakistan Earthquake, documented later in this book, we are skeptical that many of the activities currently being implemented in the name of risk reduction will have much impact. At the same time, changes in communications, transport and other systems following

[4] http://www.epodunk.com/top10/diaspora/index.html. & http://www.csmonitor.com/2005/0912/p01s01-ussc.html

(and catalysed by) the earthquake may have fundamentally reshaped risk exposure. Similarly, the major interventions to control risk in the Netherlands and India discussed above did occur within the window of opportunity when awareness and political will were high following disasters. Learning to work with this window and identifying the points of entry for doing so effectively is, as a result, both a major opportunity and a major challenge. Doing so may require both the disaster management and development communities to move beyond the frameworks used to define programmes.

The Development Context

Windows of opportunity for supporting risk reduction and adaptation as part of an ongoing development process exists in the array of projects being implemented by governments, multi-lateral and other organisations in a multitude of fields. Identifying the openings for action in these projects is challenging. Screening tools are being developed by the World Bank, ProVention and other organisations to identify projects that have particular relevance for climate adaptation and risk reduction. These tools can be used to identify windows of opportunity, such as during project development and

Mountainside slip immediately north of Muzaffarabad

interim review phases, where activities can be inserted or strengthened. They also represent a critical window of opportunity for review to ensure that mal-adaptive activities do not occur. Finally, in addition to such tools for identifying points of entry for risk or adaptation-specific interventions, *the development context represents the primary window of opportunity for strengthening the underlying systems that enable or constrain adaptation*.

The development context presents, as previously noted, particular challenges for the implementation of approaches that require fundamental changes in livelihood, land-use or other such systems. As the case studies presented later in this book clearly illustrate, individuals, communities, policy makers and other actors tend to focus on problems or opportunities present in their immediate context. As a result, approaches to development, whether community-based or driven at national policy levels, are unlikely to make fundamental rather than incremental changes in response to risks or needs that are not immediate or have not been previously experienced. In most cases, as a result, the development context

represents a poor window of opportunity for making rapid or large changes in basic systems. This is clearly illustrated by the National Adaptation Plans of Action (NAPA) that have been prepared by several countries. Most of the interventions contained in the NAPAs represent business as usual – incremental strengthening of existing programmes that address climate related hazards but little that would fundamentally change current patterns of vulnerability (Moench and Stapleton, 2007).

Although the development context provides little opportunity for restructuring systems, it is the primary period of time when emerging problems can be identified and the analysis necessary to envision alternatives can occur. Throughout the world governments and other organisations are currently analysing the impact climate change is likely to have on hazard risks in different regions. Whether the hazards are related to cyclone paths, sea-level rise or drought, the likely distribution of climate related hazards is increasingly well known. This knowledge and the opportunity for advanced planning that it presents could be utilised as a point of entry for bridging the gap between the incremental processes of change and the much more abrupt opportunities for change that can emerge in post-disaster contexts.

The Post-Disaster Context

Actions to provide humanitarian relief and begin the process of re-establishing infrastructure and livelihood systems characterise, as they should, most post-disaster contexts. Such contexts are not conducive to long-term planning or the identification of avenues for restructuring systems in ways that reduce risk or enable adaptation. Yet *if planning and the building of awareness can take place in advance of disasters in vulnerable regions, they could serve as windows of opportunity*. Existing livelihood and infrastructure systems are often disrupted and local populations are often more willing – or pushed – to make basic changes than at other times. Disasters are also times when large pulses of funding become suddenly available and when political support exists for change. As a result, if strategic approaches can be developed in advance that support effective change in highly disrupted contexts, disasters could serve as windows of opportunity to address some of the long-term, root, causes of vulnerability and unsustainable development.

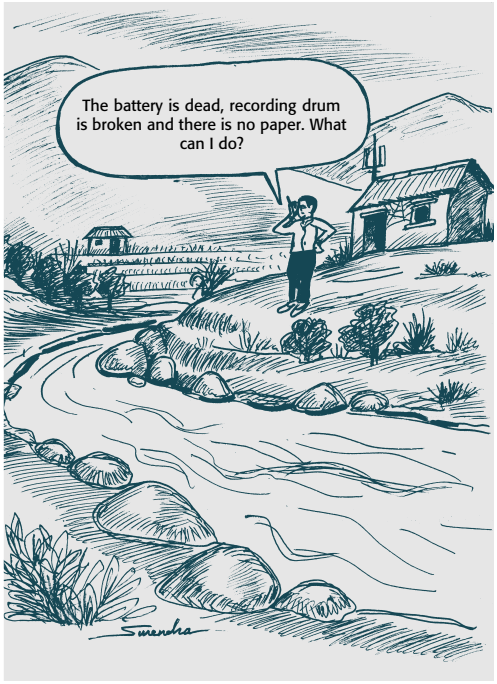
Disasters are times when large pulses of funding become suddenly available and when political support exists for change.

Learning to work more effectively with the post-disaster recovery context could also contribute to better understanding of development processes in general. Virtually all development activities focus on linear processes of change. They involve interventions that are designed to build social capacity and infrastructure in an incremental planned manner. While this type of work is important, recent research on complex systems emphasises that change is, at fundamental levels, a *pulsed* process. It often occurs in bursts or phases that are catalysed by disruption in pre-existing systems. Instability, in effect, frees resources and shatters conventional ways of doing things. This often leads to fundamental reorganisation of economic, social and livelihood systems. Reorganisation sets the stage for the next phase of more gradual 'linear' development. Attempting to recreate pre-existing conditions merely recreates pre-existing patterns of vulnerability.

Learning to work with the pulses of change that accompany disaster could lead to fundamental new insights into development processes.

Viewed in this way, disruptions, including the extreme forms that cause disaster, are windows for structural rebirth. As a result, learning to work with the pulses of change that accompany disaster could lead to fundamental new insights into development processes. By learning to work with pulsed change it may be possible to identify new windows of opportunity and strategic points of entry that are fundamentally different and can achieve results at a much larger scale than conventional linear 'development' processes.

Strategically, identification of vulnerable regions and the development of shared visions regarding alternative futures in such regions could be used to plan and develop awareness of the need for fundamental changes – even if such changes can only be implemented following disruptive events. Just as relief organisations pre-position supplies and other materials in regions that are known to be vulnerable to earthquakes or other natural hazards, advanced planning and dialogue with key stakeholders in regions that are vulnerable to climate risks could enable restructuring as part of post-disaster recovery processes. Processes for working with communities to identify sources of vulnerability – and much more importantly, to envision alternatives – represents we believe a key opportunity for bridging the gap between proactive development processes and reactive disaster recovery.



Moving from Concepts to Action

How can organisations working on disaster risk reduction or programmes to support climate adaptation move from the above principles to logically identifiable and justifiable courses of action in specific areas? The approach outlined below represents an initial attempt to move beyond screening of existing projects for climate risks toward the development of strategies that respond to location specific contexts.

A Systematic Process

The approach has four core steps: *scoping*, *building common understanding*, *structured review of potential strategies* and finally, where necessary, *financial evaluation* of the costs and anticipated benefits interventions are likely to have. These steps are designed to enable identification of specific courses of action that contribute to climate risk reduction and adaptive capacity either *directly* or by *strengthening underlying systems*. Ideally these steps should be followed by implementation and then cycle back to a new round in which incorporation of experience and learning replace scoping but the process otherwise remains the same.

The core element required throughout all of the above steps is a clear understanding of the manner in which specific types of interventions within complex systems relate to resilience and adaptive capacity. That is to say, both conceptually and practically how they enable strategy shifting or increase resilience by addressing specific constraints or responding to specific opportunities. To make this clear it is worth reiterating the core factors prior research and our own more recent analysis suggests contribute to resilience and adaptive capacity within communities. These include:

1. *Diversification* of livelihood activities, assets and financial resources particularly into non-farm and other activities that have low levels of sensitivity to climatic variability or extreme events;
2. *Mobility and communication*, particularly the ability of goods, people, information and services to flow between regions in ways that enable local populations to access markets, assets, the media and other resources beyond the likely impact of specific climatic events;
3. *Ecosystem maintenance*, particularly maintenance of the basic ecosystems services (such as drinking water) without which local populations cannot survive;
4. *Organisation*, particularly the social networks, organisations and institutional systems that enable people to organise responses as constraints or opportunities emerge;
5. *Adapted infrastructure*, particularly the design of physical structures (for water, transport, communication, etc…) in ways that can maintain their basic structure and function regardless of changes in climatic systems;
6. *Skills and knowledge*, in particular the ability to learn and the basic

educational skills required to shift livelihood strategies as required;

7. *Asset convertibility*, the development of assets or markets that enable populations to transform the nature of assets and their use as conditions evolve; and
8. *Hazard specific risk reduction*, the development of early warning, spatial planning, implementation of building codes, establishment of community DRR organisations and other systems to reduce exposure and vulnerability to known climate related hazards.

Scoping

Climate hazards and potential strategies for addressing them cut across scales and sectors.

In virtually any situation, scoping is the first step toward identification of potential avenues for risk reduction or supporting adaptation. Because climate hazards and potential strategies for addressing them cut across scales and sectors, scoping activities need to as well. In order to identify initial points of entry for reducing climate risks, scoping processes need to achieve three objectives:

First, they need to pull together current information on the nature of the risks associated with climate change for the particular area. Translating global scientific information on climate into formats usable at the local level is a key part of this first step. It is important to recognise that this information does not need to be highly specific in order to be useful. Individuals and organisations often wish to specify, for example, the maximum magnitude of storms that may be encountered or whether or not their specific area will encounter floods of a given magnitude – but advanced information on climate change may never provide information of that specificity. Information that historical storm and flood magnitudes do not reflect those likely to be encountered in the future can, however, be extremely useful for everything from the design of structures to disaster planning.

Second, scoping processes need to assess vulnerabilities, capacities (vulnerability capacity analysis – VCA) and the factors enabling or constraining different groups or regions in responding to current and the array of potential future climate conditions. This assessment needs to be guided by factors such as the eight basic elements identified in the previous section that contribute to livelihood resilience and adaptive capacity. It also needs to be conducted using a systemic perspective that recognises the links between constraints, opportunities and the behaviours of entities (individuals, communities, businesses, etc.) at levels ranging from the household to the region. Depending on the scale and focus of the assessment, information required will include the basic secondary 'data' (statistics, maps, policies, programmes, etc.) that many organisations already gather on natural hazards and vulnerability. It will also include the wide array of local level PRA and stakeholder processes currently used in many DRR or development activities at local levels. Finally, it will need to include key actors and activities in the private sector. The importance of this is clearly illustrated by the case of disaster risk reduction in Muzaffarabad (Pakistan) discussed in Chapter 8 of this publication. Our analysis suggests that following the earthquake major improvements in communications, transport, financial systems and organisation, most of it

driven by the private sector has contributed far more to sustainable risk reduction than the much discussed – but in reality relatively minor – attempts at incorporating DRR in government and relief programmes.

Third, the scoping process needs to generate initial insights regarding how emerging climate risks are perceived and the responses (if any) different groups of actors are already taking or believe may be appropriate. The core objective here is to generate understanding of how different actors (individuals, households, businesses, etc.) are actually responding to the constraints and opportunities they perceive or already face. *Who* is doing well and *why* is just as important for identifying constraints and opportunities as identification of the factors affecting particularly vulnerable groups. This type of understanding is a core source of insights on strategies to address risk that is generally not captured in conventional VCA processes.

Fourth, the scoping process needs to identify a preliminary set of potential strategies for risk reduction and supporting adaptation that: (1) address the underlying systemic factors identified in the previous section; (2) build as far as possible on the behavioural incentives, opportunities and constraints facing different groups; and (3) respond to perceptions of climate risks at the local level and from emerging global scientific information.

Building Common Understanding

Building common understanding of the risks associated with climate change and the potential strategies for addressing those risks is the second basic step in moving from concepts toward courses of action that can be implemented. The immediate objective here is to move from a preliminary identification of potential strategies to a set of approaches that could actually be implemented. This is, however, only one element. The larger objective is to build a common basis for learning that can be sustained over the long time period essential to address climate related risks. The essential element in this step is *shared learning*.

Climate change poses risks for regions that have never previously been encountered. The perceptions and activities of different communities at the local level (whether villages, businesses, governments or other actors) are, as a result, highly unlikely to represent an adequate basis for identifying or responding to the risks and vulnerabilities climate change processes will create. At the same time, the perceptions of higher-level actors (whether climate scientists, business entities or government entities), rarely reflect an understanding of local conditions or the incentives driving behaviour at local levels as households and communities respond to the opportunities and constraints they face. *Shared learning processes that are structured in relationship to the basic systemic factors known to contribute to resilience and adaptive capacity are, as a result, essential.*

Climate change poses risks that have never previously been encountered.

The case studies outlined later in this book illustrate the shared learning dialogue process partners in our programmes are developing and testing as a core step in moving from the preliminary understanding and

strategies identified during scoping, toward a menu of practical activities. It is important to recognise that shared learning dialogue processes are not a one-time activity. Developing effective responses to climate change is inherently a long-term process that, at a global level, will continue indefinitely. Knowledge, insights, challenges and strategies will evolve substantially over time in response to dynamic climate and social contexts. As a result, continuous processes for translating new insights into practical courses of action will be required. Shared learning – that is processes for building understanding between communities of actors at all levels – will be essential throughout. At a practical level, initial scoping and shared learning activities should be used to develop a list of potential actions that relate both to the core factors contributing to resilience and adaptive capacity and have sufficient support to enable implementation among involved actors.

Structured Review of Identified Actions

Following identification of potential courses of action during scoping and initial shared learning dialogues, structured review is important to ensure that these actually *do* address both the specific risks emerging as a consequence of climate change and the core factors contributing to resilience and adaptive

Sample Matrix

Potential Arenas for Intervention - A Coastal Example						
Livelihood and Economic Diversification	**Ecosystem**	**Organisation**	**Education and Skill Developmment**	**Financial and Risk Spreading**	**Communication for Adaptation (climate specific)**	**Adapted Infrastructure**
Risk & Adaptation Specific Interventions						
Adding livelihood activities outside coastal areas	Mangrove and reefs as storm buffers	Formation of DRR and rescue committee	Training about cyclone relief	Storm insurance	Storm warning system	Cyclone shelter
Non-farm, non-fishing livelihoods	Salinity control structures	Establishment of state DRR and relief organisations	Targeted strengthening of construction to increase resilience to storms	Catastrophe bonds	Strengthening communication towers	Breakwater
Underlying systems for risk reduction and adaptation						
Increasing ability to access global and regional labour and other markets	Developing productive brackish and saline water fishery and farming systems	Increasing the number and diversity of civil society organisations in coastal regions – the right to organise	Skills, such as global languages, that enable populations to access global labour and other markets	Strengthen banking system and improve access to it	Cell phones and other personal communication devices	Improving transport systems
General diversification within economic and livelihood systems	Controlling pollution to enable long-term productivity of coastal ecosystems as they change	Incubating new forms of business organisations that can utilise and manage coastal resources	Coastal specific skill training (aquaculture, tourism, etc.)	Strengthen remittance flows	Increasing access to and freedom of the media	Changing approaches to infrastructure design (houses, roads, bridges, etc.) to account for uncertainty

Note: columns can be added and activities can be targeted at specific vulnerable groups

capacity. This step has two core components: strategy mapping and strategy evaluation.

Strategy mapping involves locating identified activities or strategies within a matrix that clearly identifies the relationship between proposed activities and the factors that either directly or indirectly contribute to risk reduction and adaptive capacity. This mapping process is intended to force consideration of the real links between specific activities and underlying concepts. It is also intended as a mechanism to ensure that approaches are balanced (i.e. that they don't focus heavily on one element such as structural measures to promote hard resilience while ignoring other core dimensions). A sample matrix for coastal areas is included here showing illustrative factors contributing to climate risk reduction and adaptation directly and at a systemic level.

Strategy evaluation involves analysis of the likely risks and effectiveness associated with each activity mapped out within the above matrix. The core goal is to ensure that each of the component activities does not itself carry a high level of uncertainty with respect to its effectiveness in supporting risk reduction and adaptive capacity. This is the critical stage for returning to and evaluating identified activities in relation to the warning flags discussed in detail in the preceding section on direct risk reduction. These flags are:

1. *Low levels of diversification;*
2. *Heavy dependence on key data and technical assumptions;*
3. *Reliance on narrow assumptions regarding appropriate human incentives and behaviour;*
4. *Long lead times and high capital investments required;*
5. *Major distributional differences*; and
6. *Lack of a clear business model*.

This step will assist in weeding out strategies that may be popular or appear appropriate at a first cut but that on more systematic evaluation have substantial flaws.

Financial Evaluation

Evaluation of the costs and benefits of identified risk reduction activities can serve as a final step in moving from concepts to concrete courses of action. Methods for this have been developed and tested in a variety of situations (FEMA, 1997; Uddin, 2002; MMC, 2005; Bouwer and Aerts, 2006; Messner, Penning-Rowsell *et al.*, 2006) and many of the basic principles have been outlined here previously. These methodologies are currently being refined and will be available in subsequent publications.

Quantitative and qualitative cost-benefit analyses can highlight sensitivities to climate variabilities.

In the climate case, evaluations will need to be derived based on scenarios and historical data. While such scenarios and data can generate important insights, they cannot be relied on as a guide to future conditions. This said, it is important to recognise that scenario-based approaches can provide clear indications of the sensitivity of cost-benefit expectations in relation to key uncertainties or assumptions. Some strategies will have high benefit to cost ratios regardless of future conditions – that is they will be robust under uncertainty – while the benefits and costs associated with other strategies will depend heavily on conditions. Quantitative and qualitative cost-benefit analyses can highlight such sensitivities.

Governance of the Process

This section has focused on outlining a relatively linear process organisations could use for moving from broad concepts of climate risk and adaptation to practical courses of action. It is important to recognise, however, that processes such as the one outlined above will be occurring in highly contested contexts. The nature of problems, viable solutions, potential courses of action, ethical and other considerations are all likely to be contested. Governance of the process will, as a result, be a critical consideration.

Vulnerability is also influenced by the way technological choices are made.

While a full discussion of the governance considerations is beyond the scope of this writing, one key point is essential to make here: *pluralistic strategies involving civil society, the private sector and governments in an environment where information and perspectives can be effectively communicated are essential.*

The underlying factors determining how different groups of people cope with conditions that can cause disaster are central to understanding potential responses to climate change. *We believe these factors are rooted in the dynamics of social exclusion and the relationships between technology and the democracy of institutional pluralism.* Flexibility and the ability to switch strategies are fundamental to resilience and adaptive capacity. Social, political and economic systems that deny groups access to key technologies – whether busses for evacuation, communications, insurance or credit – reduce their flexibility, increase their vulnerability and leave them disproportionately subject to loss when extreme events occur. The case of Muzaffarabad in Pakistan clearly illustrates the central role of the private sector in creating and maintaining these systems. This role, however, must be balanced by the regulatory ability of government and the voices of civil society organisations if access is to be assured for all vulnerable groups rather than just the wealthy.

In addition to access, vulnerability is also influenced by the way technological choices are made. Whether the technology in question is a physical embankment system for controlling floods or an institutional safety net, such as an insurance system, the choice and design of technologies often depends on the degree to which decision makers in governments, organisations and the market hear and are subject to pressure from diverse voices within society. The degree to which diverse voices 'can be heard' is, we believe, heavily influenced by the balance between individualistic market structures, hierarchically organised government entities and egalitarian social organisations. This is, in turn, a critical factor determining whether or not the approaches proposed will be accessible to, and protect the interests of, different groups. This does not have so much to do with the presence of a specific form of government but with the nature of pluralistic societies and the multiple institutions, entitlements and rights systems that shape them.

What does this mean on a practical level? It implies that to be effective, approaches must involve the private sector, civil society and government actors on an equal basis. The presence of multiple voices channelled through shared learning dialogue processes and public debate are the foundation of effective governance for long-term processes such as the ones required for responding effectively to the challenges of climate change.

Conclusions

The evolution of effective strategies for reducing disaster risks and adapting to climate change represents a fundamental challenge for human society on which our common future in many ways rests. Some responses targeted at specific risks or fully documented changes in climate, are essential. There is, however, substantial uncertainty regarding how changes in climatic conditions will affect local areas. Furthermore, disasters – whether climate related or caused by other natural hazards – often occur intermittently over long time scales. As a result, it is often difficult to sustain – or even identify – narrowly targeted responses. The ability to adapt and respond effectively to surprise and change, however, depends as much on underlying systems that enable communication, transport, finance, self-organisation and learning as it does on risk specific interventions. These systems – many of which can be developed and maintained through sustainable public, private or community based operational models – represent a largely overlooked dimension in DRR and climate adaptation debates. Courses of action to strengthen them may, however, ultimately prove far more effective than generic attempts to target first order risks.

In addition to underlying systems, the post-disaster context represents a largely unexplored terrain for risk reduction and adaptation. There is, of course, a fundamental ethical dilemma in focusing on the post-disaster reconstruction context for reducing vulnerabilities that have already been identified as affecting large areas and large populations. When accumulating scientific and other evidence clearly indicates the high vulnerability of populations or specific groups in coastal and other regions, responses are essential. This said, the social organisation of human societies – the hugely differing perspectives and political positions they encompass – often makes it impossible to respond proactively to creeping or pulsed environmental problems (Glantz, 1999a; Glantz, 1999b). Few societies would, for example, support major population relocations or huge investments to alter basic infrastructure in coastal regions now as a response to sea-level rise or the likelihood of increases in storm activity. Political and popular support for actions of this nature to reduce future vulnerability is far more likely when existing systems have been disrupted. On a practical basis, therefore, change will occur in pulses. Building understanding and identifying the types of changes that can be both technically effective and socially viable represents, as a result, a major potential avenue for responding to hazards and the risks associated with climate change.

Bibliography

Benson, C. (2007). *Economic Analysis. Tools for Mainstreaming Disaster Risk Reduction*. Geneva, ProVention Consortium: 12.

Benson, C. and E. J. Clay (2002). *Disasters, Vulnerability and the Global Economy*. Washington, D.C., World Bank.

Benson, C. and J. Twigg (2004). Measuring Mitigation: Methodologies for assessing natural hazard risks and the net benefits of mitigation – A scoping study. Geneva, *ProVention Consortium*: 36.

Bouwer, L. M. and J. C. J. H. Aerts (2006). Financing climate change adaptation. *Disasters* 30(1): 49-63.

Department for International Development, (2005). *Natural Disaster and Disaster Risk Reduction Measures: A Desk Review of Costs and Benefits*. J. Samuel. London, Department for International Development, DFID: 45.

Dilley, M., R. S. Chen, *et al.* (2005). *Natural Disaster Hotspots: A global risk analysis*. Washington, D.C., The World Bank: 132.

Donga, M. and R. Mechler (2005). *Cost-Benefit Analysis - A useful instrument for assessing the efficiency of natural disaster risk management*, One World and GTZ.

Dreze, J., A. Sen, *et al.*, Eds. (1995). *The Political Economy of Hunger*. New Delhi, Oxford University Press.

FEMA, F. E. M. A. (1997). *Report on Costs and Benefits of Natural Hazard Mitigation*. Washington DC, Federal Emergency Management Agency: 57.

Glantz, M. H., Ed. (1999). *Creeping Environmental Problems and Sustainable Development in the Aral Sea Basin*. Cambridge, Cambridge University Press.

Gunderson, L. H. (1999). Resilience, flexibility and adaptive management - - antidotes for spurious certitude? *Conservation Ecology* 3(1): 7.

Gunderson, L. H. and C. S. Holling, Eds. (2002). *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, D.C., Island Press.

Holling, C. S. (2001). Understanding the Complexity of Economic, Ecological and Social Systems. *Ecosystems* 4: 390-405.

Holling, C. S. and G. K. Meffe (1996). Command and Control and the Pathology of Natural Resource Management. *Conservation Biology* 10(2): 328-337.

Hoyois, P. and D. Guha-Sapir (2004). *Disasters caused by flood : Preliminary data for a 30 year assessment of their occurrence and human impact*. Health and Flood Risk Workshop; A Strategic Assessment of Adaptation Processes and Policies, University of East Anglia, Norwich, International workshop organised by the Tyndall Centre for Climate Change Research.

IRIN, I. R. I. N. (2005). Disaster Reduction and the human cost of disaster. *IRIN Web special*, United Nations Office for the Coordination of Humanitarian Affairs: 41.

ISDR (2004). *Living with Risk: A global review of disaster reduction initiatives*. New York and Geneva, International Strategy for Disaster Reduction, United Nations.

ISDR (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. World Conference on Disaster Reduction, Kobe, Hyogo, Japan, International Strategy for Disaster Reduction.

Kabat, P., W. v. Vierssen, *et al.* (2005). Climate proofing the Netherlands. *Nature* 438(17): 283-284.

Logan, J. R. (2006). *The Impact of Katrina: Race and Class in Storm-Damaged Neighborhoods*, Brown University: 16.

Mechler, R. (2005). *Cost-benefit Analysis of Natural Disaster Risk Management in Developing and Emerging Countries*. Manual. Working paper, GTZ, Eschborn.

Messner, F., E. Penning-Rowsell, *et al.* (2006). Guidelines for Socio-economic Flood Damage Evaluation. *FLOODsite Project*. Wallingford, European Community Sixth Framework Programme for European Research and Technological Development: 181.

MMC, M. M. C. (2005). *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities:* Volume 2-Study Documentation. Washington DC, National Institute of Building Sciences: 144.

Moench, M. and A. Dixit, Eds. (2004). *Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for Responding to Floods and Droughts in South Asia*. Institute for Social and Environmental Transition-International, Boulder; Institute for Social and Environmental Transition-Nepal, Kathmandu.

Moench, M. and S. Stapleton (2007). *Water, Climate, Risk and Adaptation*. Cooperative Programme on Water and Climate, The Netherlands: 88.

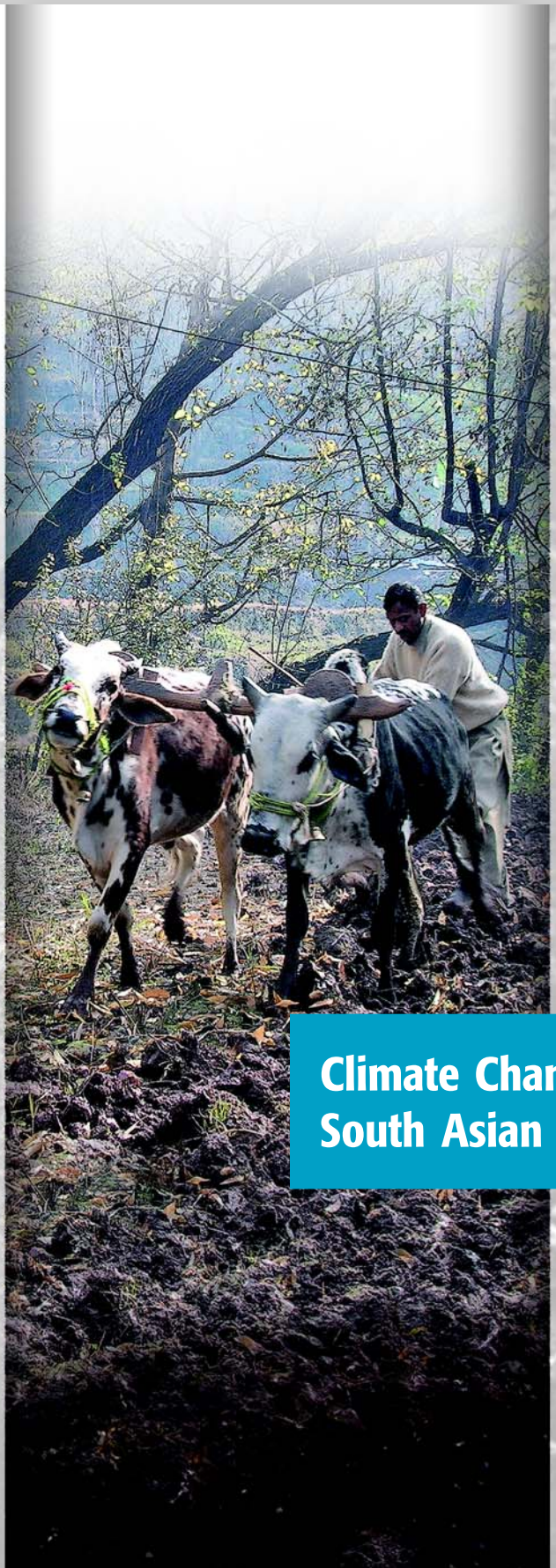
Sainath, S. (1996). *Everybody loves a good drought: Stories from India's poorest districts*. New Delhi, India, Penguin Books India.

Sen, A. (1999). *Poverty and Famines*. Delhi, Oxford University Press.

Uddin (2002). Disaster Management System in Southwestern Indiana. *Natural Hazards Review* 3(1): 19-30.

Wisner, B., P. Blaikie, *et al.* (2004). *At Risk: Natural hazards, people's vulnerability and disasters*. London, Routledge.

World Meterological Organization, Co-operative Programme on Water and Climate, *et al.* (2006). *Risk Management, Thematic Document, Framework Theme 5*. 4th World Water Forum, Mexico City, CONAGUA.



CHAPTER 3

Climate Change and South Asian Impacts

Sarah Opitz-Stapleton

Introduction

We can no longer deny that human actions are altering the climate system.

Global and regional climates are complex, dynamic systems involving feedback between the atmosphere, oceans, and land surfaces as an exchange of heat energy. Variability is inherent and regional ecosystems have evolved to accommodate a range of climate variation. Yet, we are now entering a period in which variability is increasing as the global climate system transitions to a new, unknown state. While extremely spatially and temporally detailed impacts of climate change remain unknown on both global and regional levels, enough data now exists to demonstrate significant temperature and precipitation trends in various regions around the world and alteration of storm tracks. We can no longer deny that human actions are altering the climate system. The recent IPCC summary report (2007) states "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea-level" (IPCC, 2007: 5). Furthermore, there is a "*very high confidence*[1] *that* the globally averaged net effect of human activities since 1750 has been one of warming" (p. 5).

Perceptions about the existence of climate change, human involvement, its potential impacts, and the sets of mitigation and adaptation strategies that can and should be taken, remain varied. Yet, uncertainty about specific impacts or their severity cannot be used as an excuse for inaction. Even if we were to reduce greenhouse gas emissions to the year 2000 levels, we are still committed to warming because of the time lagged heat release from the oceans. All people are currently affected by variations in climate, though some are affected more than others. Climate change will exacerbate climate variability and the inequity of impacts. Some will benefit from climate change, whereas extremely vulnerable populations without the capacity to adapt might not survive.

The countries in South Asia have some of the highest population densities in the world and some of the most climate vulnerable populations. In India, Nepal, and Bangladesh, agriculture is the primary livelihood of many individuals and is directly dependent on the regional climate pattern, which is dominated by the monsoon. Changes to the wind patterns and sea surface temperatures, for example, will alter the monsoon. Glaciers in the Himalayas supply the baseflows to many of the rivers, such as those in the Gangetic Basin. The IPCC (2007) has noted that glacier melt in the Himalayan region is increasing and will continue to increase in all global warming scenarios. With the reduction and possible disappearance of the Himalayan glaciers, the water supply of millions throughout South Asia will be significantly affected. The coastal areas are also particularly vulnerable to changes in mean sea-level. For example, significant portions of the Tamilnadu coastline have an elevation only slightly above sea-level (refer to the case study on Tamilnadu) that are already struggling with 12m storm surges. A mean sea-level rise of 0.5m

[1] In the 2007 IPCC report, a very high confidence signifies that an event has at least a 9 out of 10, or higher, chance of being correct.

(IPCC, 2007 projections) or higher (if the rate of Greenland ice sheet melt continues to accelerate, see Sheppard *et al.*, 2007) within the next century will inundate significant portions of the Tamilnadu coastline and increase the impact and extent of storm surges or tsunamis. Increases in mean precipitation and extreme precipitation events have already been observed throughout India and are expected to increase. Likewise, the number of warm nights has increased in northern India and mean temperature throughout India has increased by about 0.22ºC per decade since 1970 (Kothawale and Kumar, 2005). Increases in the frequency and intensity of precipitation events will exacerbate flooding throughout Asia, while hotter temperatures will contribute to drought and increased energy and groundwater usage.

The complete severity and range of impacts for regions of Asia, or any other region, will never be completely quantifiable or without great uncertainty. Current short-term (4-10 day) and longer term (seasonal to half year) forecasts rely on a mix of statistical and numerical forecast methods. Statistical methods are based on physical relationships between phenoma such as the Indian monsoon and El Niño that are already changing and cannot be guaranteed to hold in the future. Numerical models rely on large numbers of data sets and parameters, such as soil moisture or streamflow, which simply have not been collected for many areas of Asia. As large scale changes occur in the climate system, the reliability of forecasts generated using statistical methods is likely to decrease over the next decade. Furthermore, the ability to issue valid longer term forecasts, upon which farmers rely to make agricultural decisions, is likely to decrease.

Investigations have already noticed changing trends in various parts of the Indian climate system. The earth-climate system is dynamic and vulnerability reduction to a range of likely scenarios should be built into infrastructure and societal thinking. This chapter describes what is known about the Indian monsoon and the potential impacts of climate change for the Indian climate system. The physical mechanisms that are known to influence the development of the monsoon are presented in some detail. Observations of current changes to precipitation and temperature throughout India are also discussed. A synopsis of potential climate change impacts for the case sites is given along with a synopsis of other current investigations of possible climate change for India.

This chapter is a semi-technical description of the climate system of South Asia, particularly India. It does not discuss practical adaptive strategies which are discussed in other sections, such as the case study on Uttar Pradesh (Chapter 7) or the chapter on adapting to climate change and natural hazards (Chapter 2). In general, successful adaptation strategies to the potential impacts of climate change will have to focus on the design of relationships, policies, social and financial networks in addition to physical infrastructure. Transport of goods, services and information and financial mechanisms to risk sharing are key to capacity building and enhancing the diversification of livelihood options. Further information and ideas about adaptation strategies to climate change and natural hazards can be found in the book *Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for Responding to Floods and Droughts in South Asia* (Moench & Dixit, 2004).

The countries in Asia have some of the highest population densities in the world and some of the most climate vulnerable populations.

The Indian Monsoon and its Physical Mechanisms

For many parts of India and Nepal, nearly 80% of the annual precipitation falls during the months of June-September.

The Indian monsoon (IM) is the pattern of increased rainfall over India generally beginning about late May and extending through September. The monsoons are not confined to India alone, but extend throughout Asia (into Nepal and eastward through China) and Australia. As most of our field sites are located in India, the focus here is limited to the Indian monsoon. This section describes what is understood about the physical phenomena that contribute to the formation of the monsoon.

For many parts of India and Nepal, nearly 80% of the annual precipitation falls during the months of June-September ("JJAS" in Figure 1). The south-eastern coast of India experiences the monsoon from roughly September through December. The beginning of the Asian monsoon is marked by several changes in the atmosphere. A low pressure system develops over the Tibetan plateau and the upper-level westerly jet (wind pattern) over the southern Himalayas disappears. Winds rotate counter-clockwise around a low pressure system in the northern hemisphere, causing winds to blow from the southwest over the Indian subcontinent. The primary horizontal circulation pattern that moves moisture over the Indian subcontinent is the Walker circulation pattern. The Walker circulation pattern consists of two longitudinal (east-west) cells of circulation. The locations of convergence of the cells are marked by increased convection and precipitation. During the monsoon season, this centre of convection migrates from the pool of warm sea surface temperatures (SSTs) in the western Pacific Ocean to a more north-westerly location. As the centre of convection shifts, the monsoon region expands from India toward East Asia later in the year. The monsoon's existence is based upon large centres of moisture convergence (where storms develop) and divergence (dry spots) near western India, the Bay of Bengal, Southeast Asia, and the Arabian Sea. The monsoon ends with a west to east progression when the low pressure over the Tibetan plateau dissipates and the upper-level westerly jet resumes (Torrence and Webster, 1999; Fasullo and Webster, 2003; Meehl and Arblaster, 2002). Figure 1 displays a scenario of the ocean, land, and atmospheric mechanisms just described that lead to the formation, evolution, and termination of the Asian monsoon. How all of these mechanisms interact determines the strength of the monsoon, when it begins, and the active breaks within the monsoon.

The monsoon patterns exhibit great temporal and spatial variability from day to day, season to season and on an interannual to interdecadal timeframe. The IM tends to have break periods during which little or no rain falls, that are modulated by the Madden-Julian Oscillation (MJO) to some degree. Predicting the onset of the monsoon, its duration and strength, whether there will be breaks in the monsoon, and when it will withdraw, is not an exact science. The monsoon is dependent on

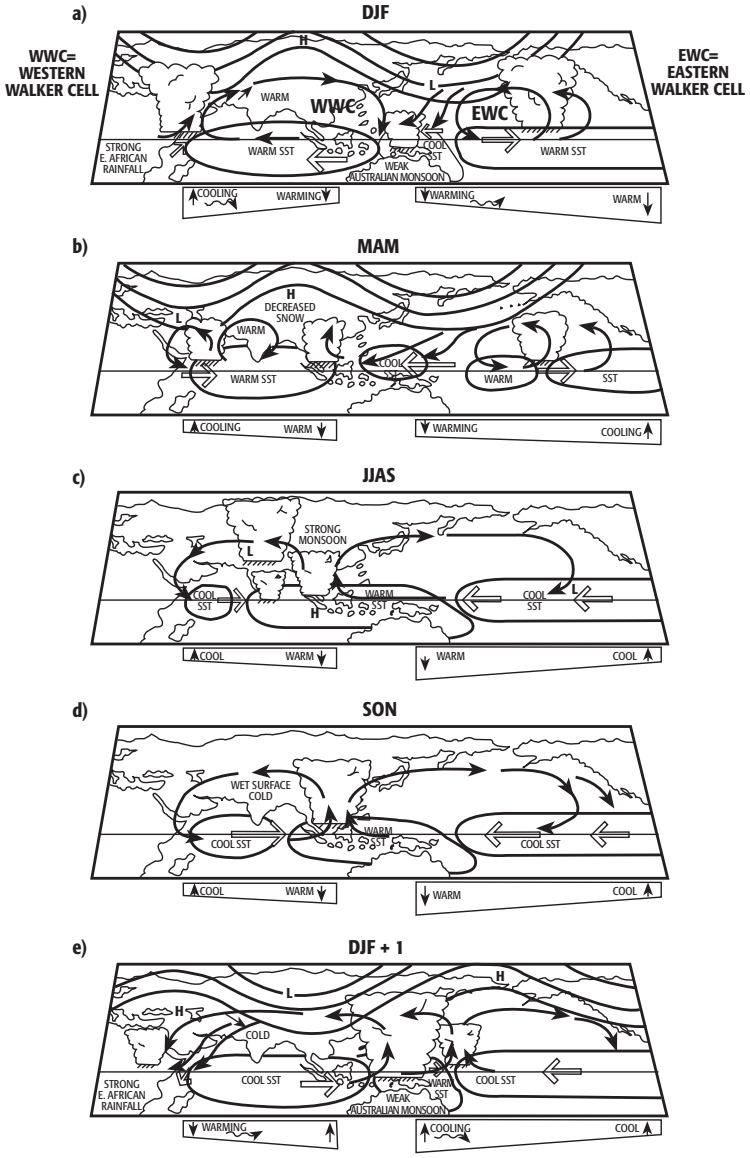
the characteristics of many physical mechanisms and the interactions between these mechanisms. For instance, how much snow falls in the Himalayas during the winter can, but not always, affect whether the monsoon will be weak or strong. Furthermore, understanding of these mechanisms is not complete. Nonetheless, relationships between the IM and the El Niño Southern Oscillation (ENSO), the MJO, the temperature of the Indian Ocean, and winter / spring snow cover of the Eurasian landmass have been discovered. Each of these mechanisms will be described in greater detail in the following subsections, in so far as the relationships are understood.

El Niño Southern Oscillation (ENSO)

ENSO is defined by changes in SST and sea-level pressure (SLP) around the equatorial Pacific. The SST anomalies are most pronounced in a narrow band extending roughly 5º N to 5º S about the equator. Variations in SLP are measured as a shift between pressures measured at Darwin, Australia, and the island of Tahiti. When high pressure is located over Darwin, a low pressure is located over Tahiti, and vice versa. The relative difference between the two pressure centres is called the Southern Oscillation (McCabe and Dettinger, 1999). The location of the pressure centres drives atmospheric circulation patterns (how and where the winds and storm tracks blow). ENSO is marked by extreme sea surface temperatures and sea-level pressures in the tropical Pacific, yet the influence of ENSO extends well into the mid-latitudes and is known to affect the IM.

Typically, the tropical west Pacific sea surface temperatures are 6º to 8º C warmer than the eastern tropical Pacific. During an El Niño year, the relative temperature difference between the two decreases and the eastern tropical Pacific warms in relation to the western tropical Pacific. In a La Niña year, the difference is enhanced and the eastern area becomes colder. Both El Niño and

FIGURE 1 | **This figure describes the progression of the various wind and pressure patterns that leads to the formation of the monsoon. In c) a centre of convection is located more or less over the Indian subcontinent.**

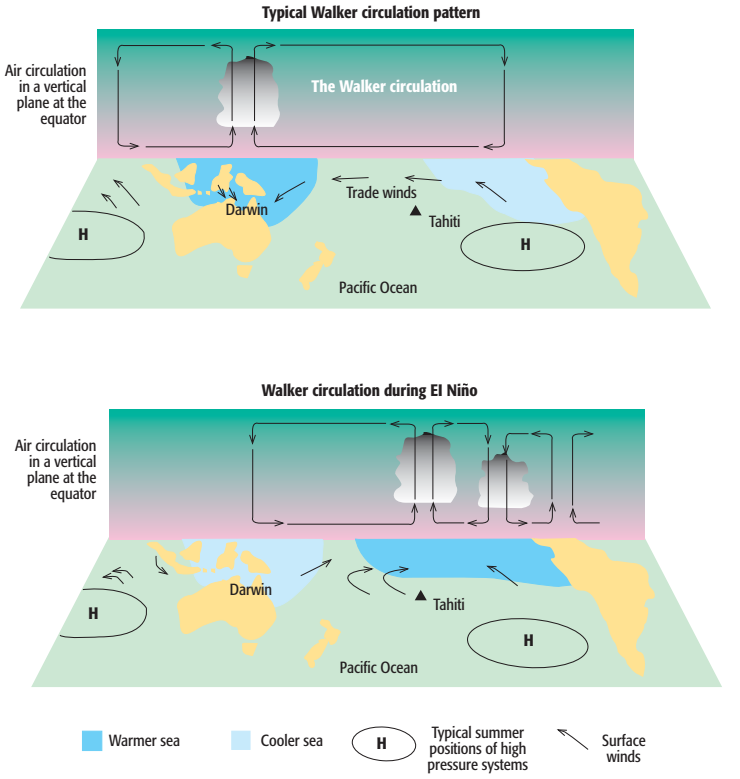


Note: Reprinted with permission. Source: From Meehl and Arblaster (2002)

La Niña shift the centres of tropical convection associated with the Walker circulation cells and thus the rainfall patterns about the equator. This happens because less evaporation occurs over cold water than warm water; storms form more easily over warm water. Figure 2 depicts the general shift of the Walker circulation pattern during an El Niño event. Generally, during an El Niño event, the Walker circulation pattern moves eastward, shifting the centre of rainfall further away from India.

ENSO events come in different flavours, some being stronger than others, lasting different lengths of time, and evolving in different locations. Furthermore, El Niño and La Niña events are not the exact linear opposites of each other (Hoerling *et al.*, 1997; Kidson, 1999). The strength of an ENSO event is determined by degree and location of anomalous warming of SSTs in the eastern Pacific (cooling in the western Pacific) and the SLP difference between Darwin and Tahiti. ENSO events are semi-periodic in nature, occurring with a frequency of roughly every two to seven years. These changes affect the average latent heat fluxes in the tropical atmosphere. The altered information propagates in a wave-like fashion through the troposphere (Wallace and Gutzler, 1981) and affects the IM. How ENSO will change under a warmer climate is not known.

FIGURE 2 **An example of how ENSO can affect the Walker circulation pattern. The warmer water and centres of convection are shifted eastward, away from the Indian subcontinent.**



Source: http://www.bom.gov.au/lam/climate/levelthree/analclim/elnino.htm#four.

The relationship between ENSO and the IM is not completely understood. Over the period of record of the all-India monsoon rainfall index (IMR) and ENSO indices, ~1870-present, the general relationship has been noted; El Niño (La Niña) events tend to correspond with dryer (wetter) IM conditions (Reason *et al.*, 2000; Kumar *et al.*, 1999a; Ihara *et al.*, 2006; Lau and Wu, 2001). Reason *et al.* (2000) performed composite and correlation analysis between the IMR, mean SLP, SSTs, and wind and cloudiness anomalies in the Indian Ocean with ENSO indices. They found that when an El Niño event occurred during the monsoon season, several changes occurred over the Indian Ocean. SSTs in the Indian Ocean warmed, weakening the land-ocean temperature gradient and reducing the zonal (south / south-westerly) wind strength and cloudiness over the Indian subcontinent. This effectively weakens the IM. A somewhat opposite relationship has been noted during La Niña events. Kumar *et al.* (2006) have also noted that where the pool of warm SSTs associated

with an El Niño event is located affects the IM. They discovered that a westward shift in the warm SST pool toward the central Pacific was more likely to reduce rainfall over India than those El Niño conditions that set up in the eastern Pacific.

Many climatologists have relied on this relationship between ENSO and the IM in generating forecasts of the IM. However, the relationship seems to be changing, which is affecting the ability to forecast the IM using ENSO indices. Recently, the expected responses of the Indian monsoon to an El Niño or La Niña event are not occurring as predicted. For example, during the 1997-1998 El Niño, which was one of the strongest events recorded, the IM was almost normal. However, India experienced a severe drought and weak monsoon in 2002, even though no strong El Niño conditions existed (Gadgil *et al.*, 2003). Many hypotheses have been put forth to try and explain why the relationship might be changing. Kumar *et al.* (1999) noted that there seem to be periods in the relationship between IM and ENSO. Between 1911 and 1950, ENSO seemed to occur in 5-7 year intervals and with less strength. In this period, the ENSO indices did not correlate strongly with the IM. Between 1951 and 1990, ENSO events were greater in strength, occurred roughly every 3-5 years, and correlated much better with IM. They hypothesise that after 1990, ENSO shifted back into a lower frequency phase and is not strongly correlated with IM. In another study, Kumar *et al.* (1999) suggest that changes to the Walker circulation pattern and the relationship between the IM and Eurasian snow cover might be offsetting the changes in the relationship between ENSO and IM.

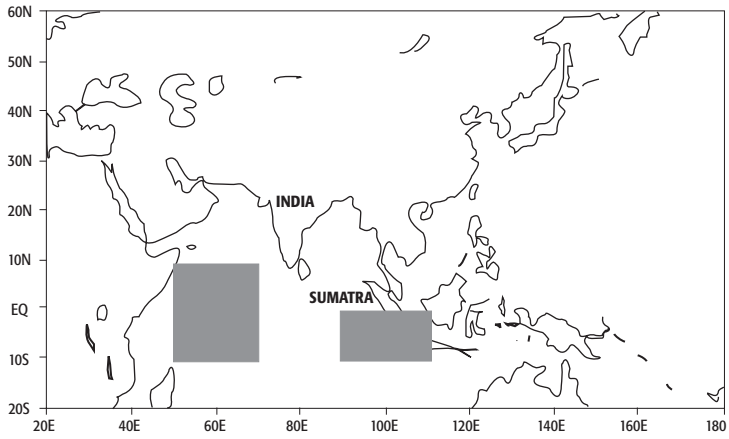
More recent work (Kumar *et al.*, 2006; Douville, 2006; Hoerling and Kumar, 2003) is hypothesising that the relationship between ENSO and the monsoon might be changing because of global warming. Hoerling and Kumar (2003) sought to explain the widespread, persistent droughts in the Northern Hemisphere between 1998-2002 and noted a strong correlation between persistently warmer SSTs in the tropical Indian Ocean and West Pacific Ocean, a cold SST anomaly in the eastern Pacific, and the warmer temperatures and decreased precipitation over the entire Northern Hemisphere for that period. They discuss that while the ocean state of a strongly persistent ENSO event could fall within the range of natural variability, paleoclimate records do not indicate that an ENSO event has occurred like the one seen in 1998-2002. Furthermore, they note the unusual warming of the tropical Indian Ocean over the past century and wonder what implications this might have for global weather and climate.

The relationship between ENSO and the monsoon might be changing because of global warming.

The Role of the Indian Ocean

Events occurring in the Indian Ocean Basin influence and are influenced by the IM and ENSO. The normal state of the Indian Ocean is warmer in the eastern part near Indonesia and cooler in the western equatorial area (see figure 3). During the late spring and early summer, warmer water extends from the equatorial Indian Ocean to the northern Arabia Sea and the Bay of Bengal, enabling full development of the IM through the land-ocean temperature gradient. However, researchers have noticed a seeming dipole condition in the Indian Ocean SSTs. The dipole mode is characterised by anomalous warming

FIGURE 3 | Location of the SST pools associated with the Indian Ocean Dipole



Note: Reprinted with permission.

Source: Kulkarni *et al.*, 2006

Researchers are trying to understand the relationship between events in the Indian Ocean and ENSO.

of the western equatorial Indian Ocean and a cooling near Sumatra (see Figure 3). This has been dubbed the positive phase of the Indian Ocean Dipole Mode (IODM). The negative phase is generally a linear opposite (Kulkarni *et al.*, 2006; Meehl and Arblaster, 2006) of the positive phase. An inverse relationship between the strength of the monsoon and the phase of the dipole seems to exist. A positive dipole tends to correlate with a weak monsoon. The weakening of the monsoon is due to convection being enhanced over the western Indian Ocean region at the expense of the eastern region. Sea-level pressure (SLP) and zonal (east-west) winds are also similarly affected (Gadgil *et al.*, 2003).

Researchers are trying to understand the relationship between events in the Indian Ocean and ENSO (Reason *et al.*, 2000; Gadgil *et al.*, 2003; Chung and Ramanathan, 2006; Ihara *et al.*, 2006; Lau and Wu, 2001). Gadgil *et al.*, (2003) found that the variability in Indian Ocean SSTs seems to be independent of ENSO. However, Reason *et al.* (2000) found that anomalous events in the Indian Ocean evolve simultaneously with ENSO events. They hypothesise that the changes seen in the Indian Ocean are due to shifts of the Walker circulation patterns, which affects cloud cover and the easterly or westerly winds. The changes in the wind anomalies around Madagascar coincide with the formation of a warm-cool (cool-warm) north-south SST dipole in the western Indian Ocean during El Niño (La Niña) years. The IODM also seems strongly correlated with ENSO events. Yet, Ihara *et al.* (2006), found that the relationship between the zonal winds and the IM is much stronger during El Niño years and insignificant in La Niña years. They note that negative zonal winds over the Indian Ocean seem to protect the strength of the monsoon in the face of an El Niño event. This result would seem to agree with Gadgil's assessment that some of the variability in the Indian Ocean is independent of ENSO.

Eurasian Snow Cover and Land Surface Temperature

The relationship between the Eurasian snow cover and the IM has been explored using a combination of snow data from the former Soviet Union that extends back to the early 1900's and more recent satellite snow depth / coverage data. Blanford (1884, as cited in Zhao and Moore, 2004) hypothesised an inverse relationship between snow cover in the western Himalayas and monsoon rainfall in northwest India. Generally, excessive (deficient) snow cover during the preceding winter leads to weak (favourable) monsoons (Kripalani *et al.*, 2003; Bamzai and Shukla, 1999). The physical mechanism by which snow cover and depth in Eurasia affects the IM is understood as this: It is theorised that more snow

implies that more solar radiation goes toward melting the snow than heating the soil in the pre-monsoon seasons. Lower soil temperatures lead to a decreased land-ocean temperature gradient, which reduces convection over the Indian subcontinent and a weaker monsoon. Also, a larger aerial extent of snow cover reflects more sunlight, which lowers atmospheric temperature, increases surface level pressure, and weakens monsoon circulation.

Researchers have sought to establish whether different regions of Eurasia have variable impacts on the IM (Kripalani and Kulkarni, 1999; Robock et al, 2003; Singh and Oh, 2005). Correlation analysis with the snow data reveals that snow depth in western (central and eastern) Eurasia is strongly negatively (positively) correlated with the IM. Kripalani and Kulkarni (1999) hypothesise that this dipole correlation is the result of a strong pressure system over Asia prior to the monsoon. An anomalously strong high pressure (low pressure) induces clockwise (counter-clockwise) circulation over Asia prior to the monsoon. All of the studies found that the longer snow cover / depth persisted into the spring, the more likely that there would be weak monsoons in India. The strong drought of 1979 in India was preceded by an anomalously snowy winter in Eurasia in which snow cover peaked in April of 1979. Thus, persistence of snow cover appears quite important to the development and strength of the IM.

Madden-Julian Oscillation

The Madden-Julian Oscillation (MJO) is best described as an eastward propagating band of changes to atmospheric circulation phenomena such as rainfall, cloudiness, SST, and wind along the equatorial regions. The MJO or intraseasonal oscillation results in changes to the tropical rainfall patterns associated with the IM on 30-60 day timescales. The active breaks and resumption of the monsoon are linked with the MJO (Singh *et al.*, 1992; Madden and Julian, 1994). Bands of clouds, leading to increased rainfall over India, propagate along a northwest-southeast axis across India. Heavy rainfall events characteristic of the MJO begin in western India and travel eastward across the subcontinent. The break cycle of the monsoon follows a similar pattern as the bands of suppressed convection follow the bands of enhanced convection. The diurnal pattern of the monsoon is also governed, to some degree, by the MJO. The centres of enhanced convection are comprised of large clusters of convective cells with life spans of 1-2 days or 6-12 hours depending on the size of the cells within the cluster. The sequence of the MJO is described as having a wave number of 1-2, meaning that for every centre of enhanced convection and rainfall, there is a centre of suppressed convection and minimal rainfall.

The diurnal and intraseasonal variability of the Madden-Julian Oscillation are key to formation of extreme rainfall events and active breaks in the Indian Monsoon.

The strength, duration, and width of the propagating bands of rainfall vary considerably on a diurnal, intraseasonal, and interannual basis. The variability of the MJO makes it difficult to predict the onset of the IM and the frequency and duration of active breaks within the monsoon season. It is also difficult to capture the diurnal variations in life cycle of the clusters within a region of active convection. Yet the diurnal and intraseasonal variability of the MJO are key to the formation of extreme rainfall events in the IM or drought if the active break cycle of the MJO is quite long.

Global Warming: Predictions based on Numerical and Statistical Models

Predicting the impacts of climate change on South Asia is hampered by lack of data, model resolution, and institutional capacity.

The amount of research being done to make predictions of climate change impacts in India is limited and constrained by lack of data and global gaps in computational power, and institutional capacity. The same limitations affect the ability to forecast the monsoon on a seasonal and annual basis. There are basically two types of models used for short-range (daily to weekly) to long-range (decadal impacts) forecasts: numerical models and statistically based models. Precipitation is traditionally forecast using numerical methods (physically-based), statistical methods (empirically-based) or a combination of the two. Each method has unique advantages and disadvantages. The two model types will be discussed in greater detail below, as well as which models are in existence and which centres or researchers are using the models. The skill of each model type in predicting the monsoon, and various aspects of the monsoon is described as well. A brief overview of the model capabilities in predicting various climate change scenarios is also discussed.

Numerical Methods

Numerical forecasts model the physical response of a basin, region, or global scale (e.g. changes in precipitation) to various sets of inputs (e.g., soil moisture, long wave radiation, or greenhouse gas concentrations). Numerical models can provide realistic response scenarios, including responses not seen in the historical record. These responses are generated by perturbing the input data. Coupled models allow for interactions between the various layers of the model. In uncoupled models, data are prescribed for one or more layers, and in only one layer are changes allowed to occur.

Numerical models rely on large sets of parameters to model a physical response. Each parameter must be calibrated for the model and assumptions made about the calibration. For example, antecedent soil moisture may be an input to a numerical model. Multiple samples must be taken from sites within the area of interest and calibrated with the assumption that the samples are representative of conditions over the entire area. As soil type is generally not homogeneous across an area, such averaging might not accurately reflect conditions. Secondly, numerical models are computationally expensive.

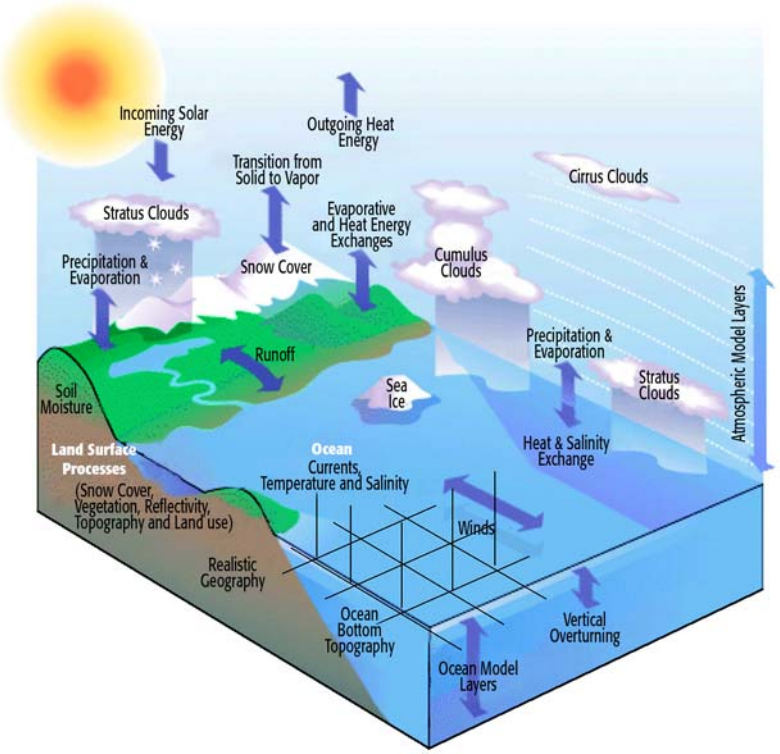
The general circulation models (GCMs) operated by various research centres throughout the world and utilised for the IPCC are numerical models. The models operate in a four dimensional framework with the spatial dimensions represented by grids (refer to Figure 4). The ocean, land, and atmosphere are broken into grid spaces / layers of varying resolution. Resolution is determined by the data available for each layer, the type of processes being modelled, and whether the layers are coupled (i.e., the processes taking place in the ocean are allowed to affect / be

affected by the processes taking place on the land or in the atmosphere). The processes typically modelled are energy and water balances. For instance, the warming of the top layer of the ocean may be described as a function of incoming solar radiation and winds.

Several centres are running publicly available GCMs, to examine climate scenarios. The following models have been used in generating scenarios for Asia: the Community Climate System Model Version 3 (CCSM3) operated by the National Center for Atmospheric Research (NCAR) and the CM2 model of the Centre National de Recherches Météorologiques (CNRM). The CCSM3 model is a fully coupled ocean-sea ice-land-atmosphere model. Each element (say the ocean) is represented by a separate model, which can be run individually, in combination, or fully coupled to generate various climate scenarios. The model operates at three different resolutions (grid spacing and number of levels in the vertical) that the user can determine (NCAR, 2004). The CNRM-CM2 model is a coupled ocean-atmosphere model incorporating 45 vertical nodes between the earth's surface and upper stratosphere and 31 vertical nodes in the boundary layers of the ocean down to about 500m below the water surface. The horizontal grid has variable spacing, typically of 2.0ºx0.5º. In general, this model overestimates temperatures in the eastern Atlantic and tropical Pacific oceans. The model also has difficulty simulating the extent (significantly underestimates) of sea ice cover in the circumpolar southern ocean, but is better in the northern Pacific and northern Atlantic (Douville, 2006).

Beyond the data limitations, the resolution of GCMs is too poor to really describe how a region's climate might be impacted under climate change scenarios. Thus, various researchers and centres are attempting to generate regional climate models that are forced at the boundaries with scenarios from the GCMs. One such model that has been used to generate scenarios for India is the Hadley Centre's Providing Regional Climates for Impacts Studies (PRECIS) model. The PRECIS model is a coupled land-atmosphere model forced at the boundaries by the Hadley Centre's GCM outputs. The resolution of PRECIS is 50km x 50km, which is better than GCMs, but still can fail to capture orographic (topography) induced behaviour (Kumar *et al.*, 2006). There are other regional numerical

FIGURE 4 | **A GCM tries to model the interactions between the atmosphere, land surface, and ocean by accounting for the various mechanisms described in the picture.**



Adapted by adding grid lines to the source diagram from NOAA.

models in existence, but in the literature PRECIS has been used to model IM response to various climate change scenarios.

In modelling the IM, GCMs have demonstrated very little skill in reproducing the variability of previous monsoons (Waliser *et al.*, 2003), raising doubt about their usefulness to predict key features of the IM. In particular, GCMs have difficulty matching features such as rainfall distribution, onset of the monsoon, diurnal and seasonal variability, and biasing certain ocean and atmospheric features in the Indo-Pacific oceans region. As noted in the previous section describing some of the key physical mechanisms that drive the monsoon, biasing of the ocean or atmospheric features can give less skillful predictions of the monsoon.

General Circulation Models have difficulty reproducing the variability of previous monsoons.

Prediction capability of MJO events and their effects on the diurnal and intraseasonal characteristics of the IM is still quite low for dynamic models. However, some improvement in numerical models is being seen. Kang *et al.* (2002) note that certain GCMs capture the interannual and intraseasonal variability better than others. While GCMs are still unable to capture any diurnal variability, they are showing some skill in forecasting active (rainy) periods with about a 5-day lead time and break periods with about a 10-day lead time (Waliser *et al.*, 2003). Waliser *et al.* (2003b) also note that the skill of GCMs in predicting MJO events is good to the order of 15 to 25 days. Such short lead times do not offer enough time for decisions that must be made on a seasonal basis, but the prediction of likely extreme rainfall with a 5 day lead is enough advanced warning to prepare for a possible flood situation. Further comparison of the specific strengths and weaknesses of 10 atmospheric GCMs in modelling the Asian monsoon can be found in Kang *et al.* (2002).

Statistical Methods

Statistically based regression forecasts are relatively easy to develop and can provide the level of accuracy needed for employment in water decision support systems, agriculture and insurance planning. Statistical techniques attempt to find a relationship between the predictand (e.g., stream flow) and the predictors (e.g., precipitation or temperature). Traditional parametric forecasts fit a linear regression between the predictand [Y_t] and a set of predictors [x]. These models take the form:

$$Y_t = a_1 x_{1t} + a_2 x_{2t} + .. + a_n x_{nt} + e_t \qquad \text{Eq. 1}$$

The coefficients (a_n) are derived from the data, often by minimising the sum of the squares of the errors. The error, e_t, is assumed to have a Gaussian distribution with a mean of 0 and variance of s_e^2. There are several drawbacks to parametric models: 1) the predictor data and errors are assumed to be normally distributed, 2) a linear relationship between variables is assumed, and 3) and the inability to use a model developed for say, Gujarat, in Tamilnadu. These issues can undermine a model's skill. For instance, the relationship between ENSO and the IM is nonlinear. As seen in the previous section, the IM responds differently to La Niña (El Niño) events. Furthermore, a model created specifically to forecast rainfall over the Western Ghats cannot be used to generate estimates of rainfall for Tamilnadu.

Nonparametric techniques estimate a local fit between the predictors and predictands. No assumptions about the functional form of the relationship (e.g., normal distribution or linear relationships) are made, which alleviates the drawbacks of the parametric models. There are several nonparametric techniques widely employed, such as kernel-based estimators, splines, K-Nearest Neighbour (K-NN) local polynomials (Rajagopalan and Lall, 1999), and local weighted polynomials (Loader, 1999). Nonparametric models take the form:

$$Y_i = m(x_i) + e_i \qquad \text{Eq. 2}$$

On shorter timescales for weather related phenomena, statistical methods generally have high predictive skill on the six- to ten-day range (Van den Dool, 1994). After that, weather predictions are not reliable. Some semi-regular features with well-documented recurrence intervals like ENSO, have decent prediction capabilities. With ENSO events, some skill exists for prediction up to a year in advance (Kirtman *et al.*, 1997).

Statistical models rely on the relationships between the predictand (e.g., rainfall) and the predictors (e.g., ENSO or regional circulation patterns) and the assumption that the historical relationships will remain unchanged in the future. This relationship reliance has three major drawbacks: 1) the data records for many variables and locations are not that long (less than 50 years), 2) data validity can be suspect, and 3) if the relationships are changing, such as is seen between the IM and ENSO, the statistical relationships may be invalidated. All three factors can seriously reduce the skill of statistical forecasts of the IM. Also, it can be difficult to choose a good model without including too many predictors. The skill of any statistical model will be artificially increased by adding more predictors. Thus, the skill of the forecasts issued by the India Meteorological Department is highly questionable as it relies on 49 independent parameters (DelSole and Shukla, 2002).

Nonetheless, statistical models continue to be used to offer forecasts of variables in India (and elsewhere) and do offer some skill (Gosain *et al.*, 2006; DelSole and Shukla, 2002). Furthermore, statistical models are still often the only way to model a small area or region's behaviour because the resolution of GCMs is too unrefined. At this point, the skill of predicting the IM and interseasonal variability is greater with statistical methods than with numerical methods, although the lead-time provided by statistical methods is a little better. However, on a seasonal basis, statistical methods can provide 3-4 months lead-time about the general strength of the IM with some skill.

The skill of statistical models might decrease as relationships between the Indian Monsoon and other climate features, such as ENSO, change.

Potential Impacts of Global Warming on India

A number of changes to precipitation and temperature in the Indian subcontinent have already been documented.

The previous section described the types of models in existence for predicting the potential impacts of global warming in India. As noted, there is still much uncertainty in predicting climate change impacts on all levels, especially on the regional to local scales. The predictions of GCMs and regional models are improving as physical processes are better understood and computational power increases. Several studies are attempting to investigate how climate variability and the monsoons in India might be impacted under various climate change scenarios. Our studies, however, are more focused on the range of impacts on particular sites within India and Nepal, the uncertainty of those impacts, and the ability to build the adaptive capacity to respond to uncertain conditions.

Observed Changes to the Climate Systems and Patterns Over India

A number of changes to precipitation and temperature in the Indian subcontinent and SSTs in the Indian Ocean have already been documented. The trends occurring over the Indian Ocean and large-scale atmospheric trends will be discussed first. Observations of variables on the Indian subcontinent are discussed second. These changes, while not accounted for in the climate change studies discussed later, are currently altering the energy and water budgets of India in ways that have yet to be understood.

Stephenson *et al.* (2001) investigated trends to the meridional and zonal winds for the period of 1958-1998. They noted that the zonal wind has been showing a decreasing trend, which they relate to a weakening of the Walker circulation pattern. The meridional wind has also been displaying a decreasing trend. For that period, the all-India monsoon rainfall is not displaying a trend one way or the other. Chung *et al.* (2006) examined the SSTs in the Indian Ocean from 1951-2002 and found that temperatures have warmed about 0.6º-0.8ºK in the equatorial Indian Ocean with little change in the northern Indian Ocean. They note that this warming trend has weakened the meridional SST gradient from the equatorial ocean to the South Asian coast during the summer. They hypothesise that if the gradient continues to weaken, monsoon circulation might also be weakened.

Both Chattopadhyay and Hulme (1997) and Kothawale and Kumar (2005) examined temperature trends across India for different time periods and noticed similar changes. Kothawale and Kumar utilised monthly temperature data from 121 stations for the period of 1901-2003. Chattopadhyay and Hulme examined both temperature and evaporation changes from 27 stations throughout India for the period of 1940-1990. Both studies grouped the temperature data into four seasons: winter (DJF), pre-monsoon (MAM), monsoon (JJAS), and post-monsoon (ON). The results of both studies show that India experienced a

warming of mean temperature in all seasons, with warming being most pronounced in the winter and post-monsoon season. The warming has been unevenly distributed, however. The western Himalayas, the northeast and northwest regions, and the Indian peninsula have experienced the most warming. Diurnal warming has occurred throughout all of India, except northern India during the pre-monsoon season. Between 1962 and 1990, Chattopadhyay and Hulme noted decreasing evaporation at certain stations in the pre-monsoon and monsoon seasons, in spite of increasing temperatures. They attribute this decrease to an observed increase in the relative humidity, which is currently offsetting the rising temperature effects on evaporation.

Projected Changes throughout India and at Case Sites

This section describes projections of climate change for India. Each of the studies published in the literature employed different models, methodologies, and datasets to generate scenarios for India. The overarching concern is how the IM might evolve under different greenhouse gas regimes, how the hydrologic cycle might be affected, and whether or not extreme events are likely to increase. Table 1 displays a summary of projected changes from three of the published studies. We have observed changes at our particular case sites and are working to enhance adaptive capacity to an uncertain range of climate impacts.

In general, the mean monsoon intensity and variability is expected to increase (Ashrit *et al.*, 2001; Chung *et al.*, 2006; Kumar *et al.*, 2006; Douville, 2006), yet each study arrives at this conclusion through different modelling outcomes and is not necessarily specific in how much the monsoon will increase. Ashrit *et al.* (2001) used a single scenario of a coupled ocean-atmosphere model to determine that the mean SSTs of the tropical Pacific will be warmer and that there will be greater variability. The IM is expected to follow similar patterns. The simulation also indicated that the relationship between ENSO and the IM will continue to weaken. Chung *et al.* (2006) were the only group to incorporate the effects of sulphate aerosols into their global warming scenarios. They concluded that the aerosols instigate a cooling trend that reduces the monsoon circulation pattern over India and shifts the rainfall to the Sahel in Africa. Models run without the effects of aerosols indicate an increase in the Indian monsoon rainfall. Chung *et al.* concludes that if the Asian brown cloud is reduced, India might see an increase in the IM strength and variability under global warming scenarios. Douville (2006) noted wide discrepancies in the SST warming patterns under various warming scenarios. When sea ice cover is reduced in the southern ocean, the southern hemisphere westerlies weaken and shift toward the equator in two of his scenarios. In the third scenario, the tropical easterly jet is weakened, but warmer oceans offset potential effects to the IM. Finally, Singh and Bengston (2005) investigated rainfall runoff, evaporation losses, and snow and glacier melt for several basins in the western Himalayas using a hydrologic model and increasing the temperature at 1º increments up to 3º. They found that evaporation increased for rainfed and mixed basins, but not in glaciated basins. Melt from glaciers and snowfields increased significantly at higher altitude basins. Table 1 synthesises potential

In general, the mean monsoon intensity and variability is expected to increase.

TABLE 1 | Synopsis of Projected Changes in Temperature, Rainfall, and Streamflow throughout India.

Region	Temperature	Rainfall/ Streamflow	Reference
All India	2.5°- 5°C	20% increase in overall monsoon	Kumar *et al.*, 2006
	3-4 per cent increase in potential evaporation (PE) per °C warming		Chattopadhyay and Hulme, 1997
Central India	8 per cent increase in PE/°C In post-monsoon		Chattopadhyay and Hulme, 1997
Ganga, Brahmani, Mahanadi, Godavari		Slight precip increases	Gosain *et al.*, 2006
Kutch, Saurastra		Acute water shortages	Gosain *et al.*, 2006
Mahi, Pennar, Sabarmati, Tapi		Some water shortage	Gosain *et al.*, 2006
Cauvery, Ganga, Narmada, Krishna		Normal streamflow	Gosain *et al.*, 2006
Godavari, Brahmani, Mahanadi		Severe flood increases	Gosain *et al.*, 2006
Punjab, Rajasthan, Tamilnadu	Max warming (3°-5°C) in NW India	Slight precip decrease during monsoon	Kumar *et al.*, 2006
Western Ghats, Maharashtra, Andra Pradesh, Madhya Pradesh, Karnataka		Increases in 1-5 day precip extremes. Up to 50% precip increase in Maharashtra	Kumar *et al.*, 2006

changes to temperature, rainfall, and stream flow for particular regions of India.

Besides the monsoon, cyclones bring intense precipitation and can enhance or cause flooding. On average, about 6 storms strong enough to be designated as cyclones develop in the northern Indian Ocean per year. Thus far, there have been no trends in either the increase of strength or frequency of cyclones since 1890 (Kumar *et al.*, 2003). It is possible that warmer sea surface temperatures due to climate change will increase the frequency and / or intensity of cyclones in the Indian Ocean region. However, various GCMs have given contradictory predictions about the impacts of climate change on cyclone formation and it is not certain what can be expected.

Next to changes in the monsoon, sea-level rise, glacier melt in the Himalayas, and an increase in the frequency and intensity of extreme weather events will have a negative impact on the livelihoods of many throughout South Asia. Significant portions of the Indian and Bangladeshi coastlines are at sea-level or only a few metres higher. The coastal areas also have some of the highest population densities as they are extremely productive zones. For instance, much of the Tamilnadu coastline is at an elevation of less than 5m above sea-level with a population density of around 500 people per km^2. The IPCC (2007: 11) is projecting a mean sea-level rise of 0.18 to 0.59m by 2090, relative to the 1980-1999 sea-levels. The report makes the following statement, however: "Models used to date do not include uncertainties in climate-carbon cycle feedback nor do they include the full effects of changes in ice sheet flow, because a basis in published literature is lacking. The projections include a contribution due to increased ice flow from Greenland and Antarctica at the rates observed for 1993-2003, but these flow rates could increase or decrease in the future." The cut-off date for reports and information included in the IPCC report was 2005. Studies released in 2007 (Sheppard *et al.*, 2007), indicate that the Greenland ice sheets are melting more rapidly than the climate models predicted. Combined, the Greenland and Antarctic ice sheets contain enough water to raise global sea-levels by about 70 metres. Paleoclimate records show that, in

the past, sudden collapses of the Greenland ice sheets raised sea-levels by as much as 20 metres in less than 300 years (Sheppard *et al.*, 2007). If this were to happen again, much of the coastline would be inundated and a massive inland migration of millions of Indians, Bangladeshis, and other coastal populations would occur. Furthermore, the magnitude of storm surges would be greatly increased. 12-metre storm surges have occurred in Tamilnadu, wreaking great havoc (see the case study on Tamilnadu). Any increase to the mean sea-level will increase the impact and extent of land affected by storm surges.

Flooding associated with extreme precipitation events and the monsoon heavily affects regions of Nepal and India. For instance, flooding in the Nepal Tarai and Uttar Pradesh routinely floods agricultural lands, washes away livestock and possessions, and leaves many villages inundated. Under a range of climate change scenarios, the frequency and intensity of extreme precipitation and temperature events is expected to increase. A warmer atmosphere holds more moisture. Klein *et al.* (2005) have noted an increase in the number of extreme precipitation events throughout southern India and on its northwest coast, and in parts of Nepal for the period of 1960-2001. At the same time, seasonal monsoon rainfall has increased by up to 10% along the west coast, north Andhra Pradesh and northwest India (Kumar *et al.*, 1992). A decrease in monsoon rainfall of around 8 per cent and an increase in drought events have been observed for east Madhya Pradesh and the adjoining areas, northeast India, parts of Gujarat and Kerala (Klein *et al.*, 2005; Kumar *et al.*, 1992). Kumar *et al.* (2006) are projecting an overall increase of up to 20% in the monsoon rainfall and an increase in extreme precipitation events for the Western Ghats, Maharashtra, Andra Pradesh, Madhya Pradesh, and Karnataka. At the same time, a decrease in monsoon rainfall is expected in Punjab, Rajasthan and Tamilnadu. Gosain *et al.* (2006) project water shortages throughout Kutch, Saurastra, Mahi, Pennar, Sabarmati, and Tapi. These various studies indicate the imprecise nature of predicting the regional impacts of climate change and also highlight that the impacts are likely to be quite different for various regions of South Asia.

Potential Impacts of Climate Change on Social Systems and Livelihoods

None of the previous studies examined climate change impacts within the contexts of human vulnerability or activity. They only incorporated climate indices and investigated hydrologic changes without direct inclusion of potential changes to human behaviour patterns such as population increases, water demands, or land use alterations. Yet, human behaviour will directly influence energy and water balances, thus affecting circulation patterns and the monsoon rainfall in ways that are not considered by the previous studies. The set of studies that are summarized below all attempt to examine the impacts of climate change on India while incorporating aspects of human behaviour.

Mall *et al.* (2006) attempted to investigate how climate change and human consumption needs / patterns will combine to affect water availability in India. They begin by noting that a warmer climate will alter rainfall

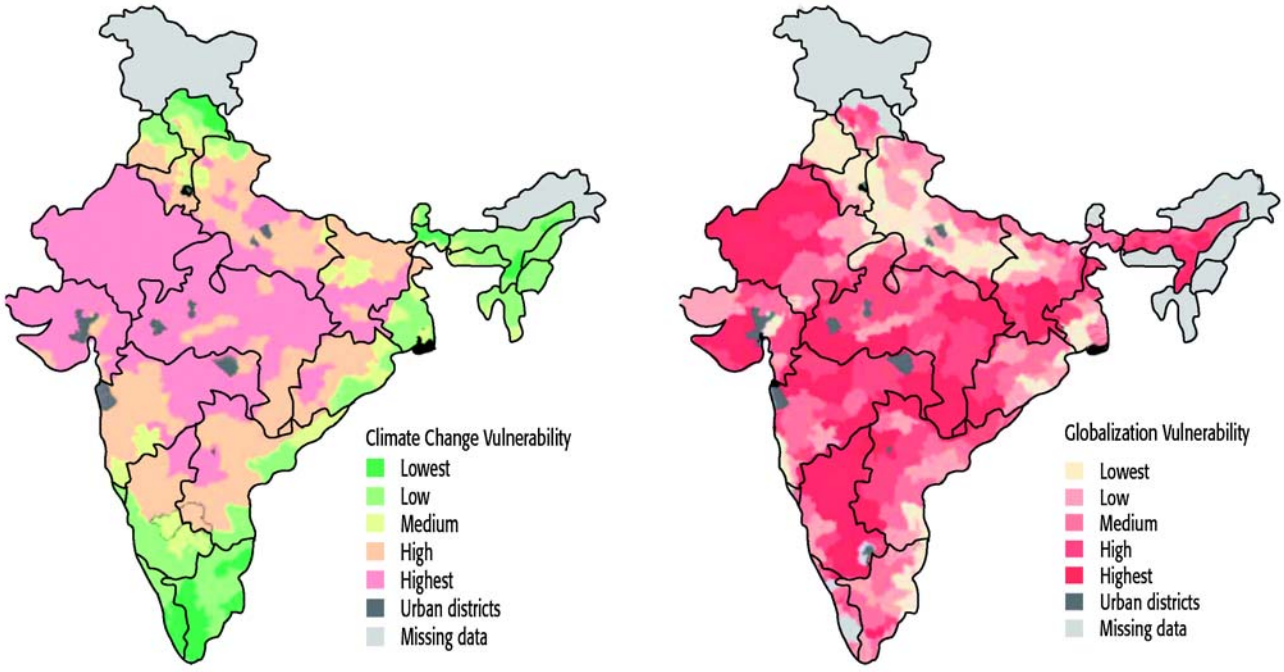
Any increase to the mean sea-level will increase the impact and extent of coastal land in South Asia affected by storm surges, cyclones, and saltwater inundation.

India's population is expected to increase to 1.3 billion by 2020. Food production/ importation will need to increase by 50% to meet population needs.

patterns, evaporation rates, recharge rates to aquifers, and extreme events such as droughts and floods. Mall *et al.* estimate that groundwater currently meets 80% of domestic needs in rural areas, 50% in urban areas, and 50% of agricultural irrigation needs. Between 1950 and 1990, the area under irrigation tripled to 99.1 million hectares, with 52.2 mha being irrigated by groundwater. India's population is expected to increase to 1.3 billion by 2020 and Mall believes that food grain production / importation will need to increase by 50% to meet the burgeoning population needs. The rising population will have greater water needs, increasing withdrawal rates and decreasing recharge time to aquifers. This will cause problems in particular areas, especially the drier states of India.

O'Brien *et al.* (2004) utilise vulnerability mapping and local case studies of Indian agriculture to investigate regional vulnerability to climate change and economic globalisation. The authors contend that there have been no systematic methodologies developed for assessing regional vulnerability to multiple stressors. The study developed vulnerability profiles to climate change and globalisation by assessing each region's adaptive capacity, sensitivity, and exposure to the stressors. Adaptive capacity was measured in terms of the biophysical, socioeconomic, and technological factors that influence agricultural production. Sensitivity to climate change was examined in the context of drought sensitivity and the average of extreme rainfall events. Sensitivity to economic globalisation was measured in terms of cropping patterns, crop productivity, and the distance of the district to the nearest international port. Separate vulnerability maps to climate change

FIGURE 5 | District level mapping of climate change vulnerability (left map) and globalisation vulnerability (right map).



Note: Reprinted with permission.

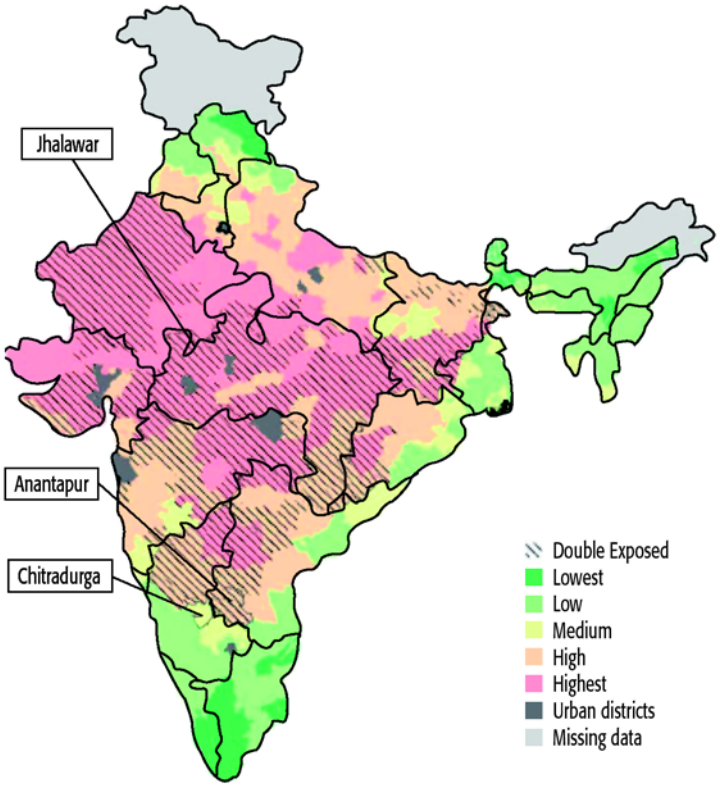
Source: O'Brien *et al.* (2004)

and economic globalisation were generated. The two maps were then overlaid to determine which regions of India are "double exposed" to stressors. The maps are presented in Figures 5 and 6.

When measuring adaptive capacity as a composite of the indices previously mentioned, the authors found that the Indo-Gangetic Plains (except Bihar) have the highest degrees of adaptive capacity. The states of Bihar, Rajasthan, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka have the lowest. The areas of greatest climate sensitivity are Rajasthan, Gujarat, Punjab, Haryana, Madhya Pradesh and Uttar Pradesh using current climatology. Under the climate change scenarios of the Hadley Centre's HadRM2 model, Uttar Pradesh, Madhya Pradesh and Maharashtra become even more sensitive to climate. The states of Rajasthan and Karnataka, and parts of Bihar, Madhya Pradesh, Maharashtra, Gujarat, and Assam are the most vulnerable to globalisation. The areas that face "double exposure", that is, are vulnerable to both climate change and globalisation, are: Rajasthan, Gujarat, Madhya Pradesh, southern Bihar and western Maharashtra.

Sathaye *et al.* (2006) view climate change within the larger context of sustainable development and argue that policies and development strategies need to account for climate change within the broader context. Sathaye's study is more policy-oriented rather than an actual study of potential climate change impacts in India, but presents an opportunity to rethink the framework of the climate discussion. The authors note that on the international level, mitigation measures continue to dominate the climate discussion and adaptation is not given enough exposure. By adopting climate change issues within the larger context of sustainable development, the authors suggest that the inertia for taking action related to climate change can be overcome. The authors argue, for India in particular, that the immediate issues India is facing are related to freshwater shortages, food security, forest and land degradation, and pollution. Climate change will only exacerbate these issues and the adaptive capacity of rural India is low. Thus Sathaye *et al.* conclude that adaptation to climate change should be considered within the context of sustainable development.

FIGURE 6 **Composite map of climate change vulnerability and globalisation vulnerability on the district level. Crosshatched areas are doubly exposed and the most vulnerable.**



Note: Reprinted with permission.

Source: O'Brien *et al.* (2004)

Summary

The intensity and frequency of extreme climate events is expected to increase in most global warming scenarios.

While the India or Nepal specific impacts of various climate change scenarios are not known with a high degree of certainty, the severity of global consequences for each °C of warming is better known. Numerical models are improving significantly and scientists are using these models to predict possible changes to Southeast and Southwest Asia's climate. It has been demonstrated that the Asian monsoon is strongly coupled with events occurring in the Indian and Pacific Oceans and the Eurasian landmass. The feedback mechanisms between the IM and ENSO and the IODM are being investigated. As the oceans and land warm, the temperature gradients that give rise to the monsoon are being altered. Studies are indicating that overall monsoon precipitation and temperature are likely to increase in India over the next century. Some studies are attempting to ascertain how the hydrologic cycles of various basins throughout India will be altered under various greenhouse gas warming scenarios.

In general, the following points are to be made about the ability to forecast the IM on a short-term basis (~5 to 10 years) and the ability to forecast the monsoon under uncertain climate regimes due to global warming:

- For the near future (~5-10 years), the skill of statistical models in capturing the essential features of the IM is likely to remain quite reliable. However, as the physical relationships between ENSO, the MJO, and the IM change, for example, it cannot be guaranteed that statistical methods will offer any skill much into the future.
- The resolution and capturing of physical processes associated with the IM are improving in GCMs. It is probable that the skill of GCMs and regional GCMs will surpass that of statistical methods in the future.
- Statistical models are currently able to provide a general overview of monsoon strength up to four months in advance. Neither statistical models nor numerical models can provide more than 6-10 days notice of the intraseasonal variability. Efforts are underway to predict breaks in the IM with greater skill and lead-times.
- The latest summary of the IPCC (IPCC, 2007) indicates that ice sheets are melting at a much faster rate than expected, which will contribute greatly to sea-level rise. Coastal communities are at greater risk from mean sea-level rise and larger storm surges associated with cyclones or other extreme climate events.
- Mean sea-level rise of at least 0.5 meters is very likely over the next century (IPCC, 2007). Higher levels are possible, especially if the rate of ice melt from Greenland and Antarctica accelerates.
- The mean global temperature is expected to rise 1.8 to 4.0°C over the next century (IPCC, 2007).
- The frequency and intensity of extreme climate events, defined as those climate events causing significant social and economic loss, are expected to increase in most global warming scenarios. The resolution

limitations of GCMs currently hamper the ability to forecast the increase in frequency or strength of events for particular regions.

- The warming trends already seen throughout India are very likely to continue. Warmer temperatures will lead to greater evapotranspiration and the need for increased irrigation. A warmer atmosphere can also hold more moisture, increasing the chances for more extreme precipitation events. The semi-arid regions of India will likely experience more drought events under a warmer temperature regime.

Very few studies that focus on the regional climate relationships and impacts are incorporating the changes in land use, water use, and air pollution that are occurring on the Indian subcontinent. Population increases and expectations of improved living situations will alter how people use resources. Increased irrigation and water demand, coupled with vast and rapid changes to vegetation types have significant impacts on evapotranspiration, soil moisture, and land and atmospheric temperatures. The sulphate aerosol concentrations associated with the Asian brown cloud also tend to have a cooling effect that might be masking some of the warming effects in the region. Changes in the levels and aerial dispersion of the brown cloud will impact precipitation and temperature regimes in Asia. However, there is very little systematic documentation of the relationships between current human behaviour and climate systems, at least that is publicly available.

Despite uncertainty surrounding region specific impacts of climate change, communities and institutions must take action. Mitigation and adaptation strategies must be discussed and implemented and are more likely to be cost effective if subsumed under an all-hazards approach. Furthermore, dialogue between the "developed" and "developing" countries needs to occur over the meaning of sustainable development and responsibilities of climate mitigation and adaptation. Communities and economic activities already experiencing difficulty in adapting to current climate variability are likely to experience even more hardship under a highly variable climate system. The recently released Stern Review (2006) synthesises the impacts of climate change on the global economy and further highlights the importance of taking action now.

Finally, the fourth assessment of the Intergovernmental Panel on Climate Change will be released later this year (2007). The policymaker summaries (IPCC, 2007) indicate that the temperature increases seen in the past decade are unprecedented and very likely caused by human activity. The glaciers and ice sheets of Greenland and Antarctica are melting much faster than the models predicted which will raise the mean sea-level, change ocean chemistry / salinity, and affect the ocean's ability to absorb heat from the atmosphere. Furthermore, global mean temperatures will continue to rise even if greenhouse gas emissions were to be stabilised at the year 2000 levels (IPCC, 2007). The information released in the IPCC report has a high confidence level and indicates that drastic climate changes will occur because of human activities. Thus adaptation and mitigation measures must begin as soon as possible, in order to lessen the impacts of climate change on societies and ecosystems.

Despite uncertainty surrounding region specific impacts of climate change, communities and institutions must take action.

Bibliography

Ashrit, R.G., *et al.* (2001). ENSO-Monsoon relationships in a greenhouse warming scenario. *Geophysical Research Letters* 28(9): 1727-30.

Australian Government Bureau of Meteorology (2006). Climate Education: Climate variability and El Niño, http://www.bom.gov.au/lam/climate/levelthree/analclim/elnino.htm#four, accessed: 22/11/06.

Bamzai, A.S., & J. Shukla. (1999). Relation between Eurasian Snow Cover, Snow Depth, and the Indian Summer Monsoon: An Observational Study. *Journal of Climate* 12: 3117-32.

Chattopadhyay, N., & M. Hulme. (1997). Evapotranspiration in India under conditions of recent and future climate change. *Agricultural and Forest Meteorology* 87: 55-73.

Chung, C.E., & V. Ramanathan. (2006). Weakening of North Indian SST Gradients and the Monsoon Rainfall in India and the Sahel. *Journal of Climate* 19: 2036-45.

DelSole, T., & J. Shukla. (2002). Linear Prediction of Indian Monsoon Rainfall. *Journal of Climate* 15: 3645-58.

Douville, H. (2006). Impact of Regional SST Anomalies on the Indian Monsoon Response to Global Warming in the CNRM Climate Model. *Journal of Climate* 19: 2008-24.

Fasullo, J., & P.J. Webster. (2003). A Hydrologic Definition of Indian Monsoon Onset and Withdrawal. *Journal of Climate* 16: 3200-11.

Gadgil, S., *et al.* (2003). Droughts of the Indian summer monsoon: Role of clouds over the Indian Ocean. *Current Science* 85(12): 1713-19.

Gosain, A.K., *et al.* (2006). Climate change impact assessment on hydrology of Indian river basins. *Current Science* 90(3): 346-53.

Helsel, D.R., & R.M. Hirsch. (1995). Statistical Methods in Water Resources. Elsevier Science B.V., Amsterdam.

Hoerling, M., & A. Kumar. (2003). The Perfect Ocean for Drought. *Science* 2999: 691-94.

Hoerling, M.P., *et al.* (1997). El Nino, La Nina, and the Nonlinearity of Their Teleconnections. *Journal of Climate* 10: 1769-86.

Ihara, C., *et al.* (2006). Indian Summer Monsoon Rainfall and its Link with ENSO and Indian Ocean Climate Indices. *International Journal of Climatology DOI: 10.1002/joc.1394*.

Intergovernmental Panel on Climate Change, Working Group I (2007), Climate Change 2007: The Physical Basis, Summary for Policymakers.

Kang, I.S.,*et al.* (2002), Intercomparison of the climatological variations of Asian summer monsoon precipitation simulated by 10 GCMs, *Climate. Dynamics* 19: 383-395.

Kidson, J.W. (1999). Principal Modes of Southern Hemisphere Low-Frequency Variability Obtained from NCEP-NCAR Reanalyses. *Journal of Climate* 12: 2808-30.

Kirtman, B.B.,*et al.* (1997), Multiseasonal predictions with a coupled tropical ocean global atmosphere system, *Monthly Weather Review* 125: 789-808.

Klein Tank, A.M.G., *et al.* (2006), Changes in daily temperature and precipitation extremes in central and south Asia, *Journal of Geophysical Research* 111 *(*doi:10.1029/2005JD006316*).*

Kothawale, D.R., & K.R. Kumar. (2005). On the recent changes in surface temperature trends over India. *Geophysical Research Letters* 32 *(L18714, doi:10.1029/2005GL023528).*

Kripalani, R.H., & A. Kulkarni. (1999). Climatology and variability of historical Soviet snow depth data: some new perspectives in snow-Indian monsoon teleconnections. *Climate Dynamics* 15: 475-89.

Kripalani, R.H., *et al.* (2003). Western Himalayan snow cover and Indian monsoon rainfall: A re-examination with INSAT and NCEP/NCAR data. *Theoretical and Applied Climatology* 74: 1-18.

Kulkarni, A., *et al.* (2006). Association between extreme monsoons and the dipole mode over the Indian subcontinent. *Meteorology and Atmospheric Physics DOI 10.1007/s00703-006-0204-9*.

Kumar, K.K., *et al.* (1999a). Epochal changes in Indian monsoon-ENSO precursors. *Geophysical Research Letters* 26(1): 75-78.

Kumar, K.K., *et al.* (1999b). On the Weakening Relationship Between the Indian Monsoon and ENSO. *Science* 284: 2156-59.

Kumar, K.K., *et al.* (2006). Unraveling the Mystery of Indian Monsoon Failure During El Nino. *Science* 314: 115-19.

Kumar, K.R., *et al.* (1992), Spatial and subseasonal patterns of the long-term trends of Indian summer monsoon rainfall, *International Journal of Climatology* 12(3): 257-268.

Kumar, K.R., *et al.* (2006). High-resolution climate change scenarios for India for the 21st century. *Current Science* 90(3): 334-46.

Lau, K.M., & H.T. Wu. (2001). Principal Modes of Rainfall-SST Variability of the Asian Summer Monsoon: A Reassessment of the Monsoon-ENSO Relationship. *Journal of Climate* 14: 2880-95.

Loader, C.R. (1999). Locfit: An Introduction. cm.bell-labs.com/stat/project/locfit.

Mall, R.K., *et al.* (2006). Water resources and climate change: An Indian perspective. *Current Science* 90(12): 1610-27.

McCabe, G.J., & M.D. Dettinger. (1999). Decadal Variations in the Strength of ENSO Teleconnections with Precipitation in the Western United States. *International Journal of Climatology* 19: 1399-410.

Meehl, G.A., & J.M. Arblaster. (2002). The Tropospheric Biennial Oscillation and Asian-Australian Monsoon Rainfall. *Journal of Climate* 15: 722-44.

Moench, M. and A. Dixit, Eds. (2004). *Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for Responding to Floods and Droughts in South Asia*. Institute for Social and Environmental Transition-International, Boulder; Institute for Social and Environmental Transition-Nepal, Kathmandu.

National Center for Atmospheric Research (2004), CCSM3 Public Release Home Page, http://www.ccsm.ucar.edu/models/ccsm3.0/, accessed 22/11/06.

O'Brien, K., *et al.* (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change* 14: 303-13.

Rajagopalan, B., & U. Lall. (1999). A k-nearest-neighbor simulator for daily precipitation and other weather variables. *Water Resources Research* 35(10): 3085-101.

Reason, C.J.C., *et al.* (2000). ENSO and Climatic Signals across the Indian Ocean Basin in the Global Context: Part 1, Interannual Composite Patterns. *International Journal of Climatology* 20: 1285-327.

Robock, A., *et al.* (2003). Land surface conditions over Eurasia and Indian summer monsoon rainfall. *Journal of Geophysical Research* 108(D4, 4131).

Sathaye, J., *et al.* (2006). Climate change, sustainable development and India: Global and national concerns. *Current Science* 90(3): 314-25.

Shepherd, A., *et al.* (2007), Recent Sea-level Contributions of the Antarctic and Greenland Ice Sheets, *Science* 315: 1529-1532

Singh, G.P., & J.-H. Oh. (2005). Study on Snow Depth Anomaly over Eurasia, Indian Rainfall and Circulations. *Journal of the Meteorological Society of Japan* 83(2): 237-50.

Singh, P., & L. Bengtson. (2005). Impact of warmer climate on melt and evaporation for the rainfed, snowfed and glacierfed basins in the Himalayan region. *Journal of Hydrology* 300: 140-51.

Stephenson, D.B., *et al.* (2001). Searching for a fingerprint of global warming in the Asian summer monsoon. *Mausam* 52(1): 229-44.

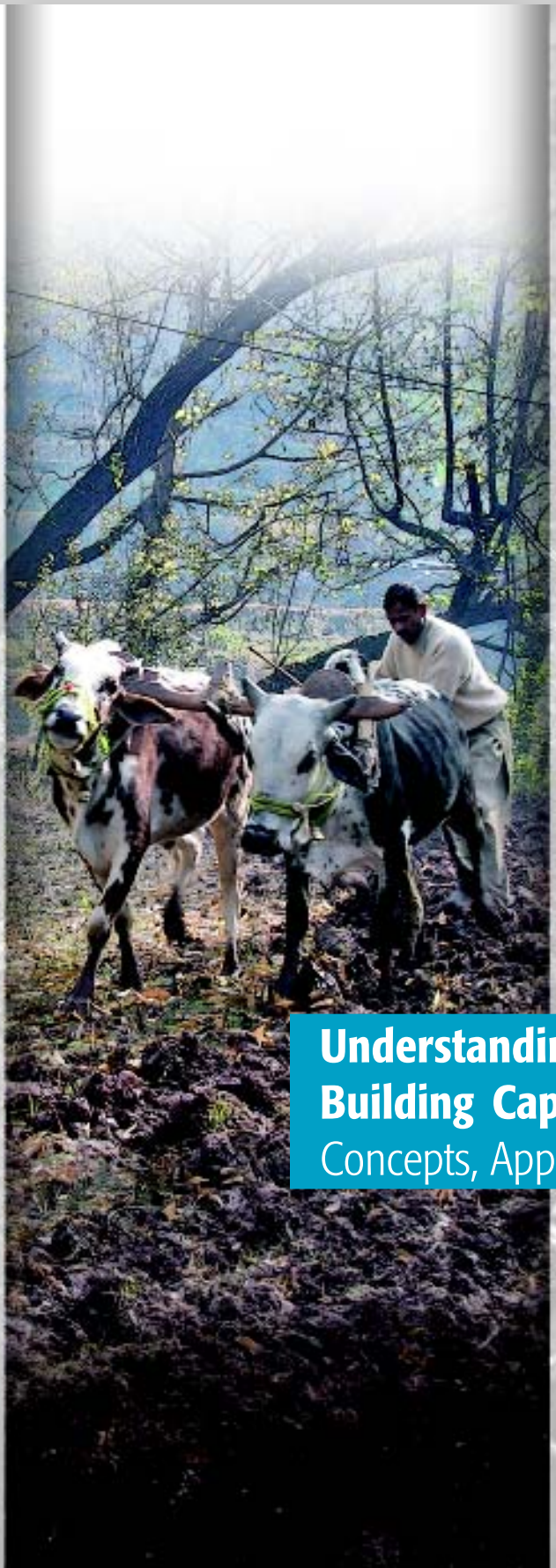
Torrence, C., & P.J. Webster. (1999). Interdecadal Changes in the ENSO-Monsoon System. *Journal of Climate* 12: 2679-2690.

Waliser, D.E., W. Stern, S. Schubert, & K.M. Lau (2003), Dynamic predictability of intraseasonal variability associated with the Asian summer monsoon, *Quarterly Journal Royal Meteorological Society* 129: 2897-2925.

Wallace, J.M., & D.S. Gutzler. (1981). Teleconnections in the Geopotential Height Field during the Northern Hemisphere Winter. *Monthly Weather Review* 109: 784-812.

Van den Dool, H.M. (1994), Long-range weather forecasting through numerical and empirical methods, *Dynamic Atmosphere and Oceans*, 20: 247-270.

Zhao, H., & G.W.K. Moore. (2004). On the relationship between Tibetan snow cover, the Tibetan plateau monsoon and the Indian summer monsoon. *Geophysical Research Letters* 31: *(L14204, doi:10.1029/2004GL20040).*



4

CHAPTER

Understanding Vulnerability, Building Capacity: Concepts, Approaches and Insights

Sara Ahmed and Daanish Mustafa

Introduction: Why Vulnerability?

What makes people vulnerable? To most people today, this is an everyday question that is as simple as it is complex.

(Hilhorst and Bankhoff, 2004: 1)

We tend to think of vulnerability as a conceptual lens and a discourse that facilitates engagement with both the biophysical aspects of disaster risk and the social structures that create the conditions of differential risk in society.

The concept of vulnerability is at the heart of our understanding of how communities and natural systems, institutional structures and social relationships are affected by climate variability and disaster risk. Writing in the late 1980s, Robert Chambers sought to distinguish between the poor / poverty and the vulnerable / vulnerability. According to Chambers, poverty is 'deprivation, lack or want' while he describes vulnerability as '(being) defencelessness, insecurity and exposure to risks, shocks and stress' (Chambers, 1989 in Yamin *et al.*, 2005: 4). Another disasters expert identifies 11 different forms of vulnerability ranging from natural and physical to ideological, social and technical (Wilches-Chaux, 1989 cited in Smith, 2004).

Beyond its material reality we tend to think of vulnerability as a conceptual lens and a discourse that facilitates engagement with both the biophysical aspects of disaster risk and the social structures that create the conditions of differential risk in society. This paper will briefly revisit the conceptual debates surrounding the concept of vulnerability. It will outline our common understanding of the concept and describe our attempts at formalising the concept and testing a quantitative index of vulnerability. In so doing, we acknowledge the diversity of definitions, frameworks and approaches to vulnerability assessment and seek to build a critical, integrative analysis that links the political and physical economy of environmental-societal change. Our analysis is contextually embedded in the field realities of our project areas and draws on insights and perceptions of vulnerability from a range of actors at different institutional levels (communities, local NGOs and state agencies, for example state agencies).

Defining Vulnerability

Vulnerability is a '*set of conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of a community to the impact of hazards,*' (The Hyogo Framework 2005-2015, adopted by the UN at the World Conference on Disasters in 2005).

Vulnerability is a contested term which has its origins in the natural hazards and food security literature (Vincent, 2004: 1). An analysis of different definitions of vulnerability distinguishes between two epistemological approaches. The natural hazards and disasters school of thought arises out of positivist approaches to development and is rooted in the technological management of risk (Cutter, 1996). It focuses on external aspects such as the frequency or probability of physical hazards and the likely intensity of exposure or risk–expected damage and loss–due to the combination of vulnerability and hazards. Such a physical understanding of vulnerability is usually manifested in the mapping of

hazard-prone areas through probabilistic modelling methods, remote sensing technologies and GIS. In this approach, risk reduction is largely seen as a physical function of infrastructure hardening, such as, building earthquake resistant houses, flood embankments or cyclone shelters.

Disasters = vulnerability (internal susceptibility or defencelessness) + hazard (an external event). A disaster cannot occur if there are hazards with little or no vulnerability, or if vulnerability is high, but there are zero hazards in a given area.

The social vulnerability approach starts by assessing vulnerabilities already embedded in a given social context: 'the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process),' (Wisner *et al.*, 2004: 11). It looks at the construction of 'social space' (Bohle *et al.*, 1994) as governing the conditions that determine exposure to risk, coping capacity and recovery potential of individuals and communities.

According to Cannon (1994): 'There are no really generalised opportunities and risks in nature, but instead there are sets of *unequal access to opportunities and unequal exposure to risks* which are a consequence of the socio-economic *(and increasingly, political)* system….It is more important to discern how human systems themselves place people in relation to each other and to the environment than it is to interpret natural systems,' (cited in Morrow, 1999: 2). Such a formulation posits that vulnerability is not a function of environmental extremes but rather everyday social existence–i.e. vulnerability as a context rather than an outcome. More specifically, the contextualisation of disasters within *everyday* vulnerabilities recognises the role of interlocking systems of vulnerability in both physical and social space, that is the construction of overlapping 'geographies of vulnerability' (Fordham, 1999: 19).

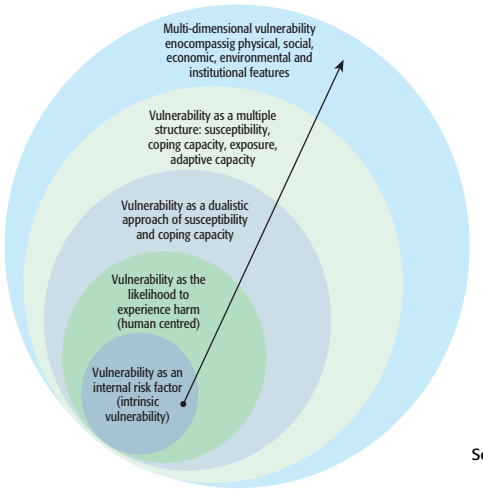
Aspects of Vulnerability

- **Physical/Material:**
  - Hazard prone location of community settlements
  - Access to infrastructure (roads, disaster-proof shelter)
  - Access to information, communication services
  - Access / control of productive resources (credit, land)

- **Social/Power:**
  - Personal endowments (skills, knowledge, literacy, time)
  - Institutional structures (family, community, power relations)

The natural hazards and disasters approach to vulnerability is rooted in the technological management of risk, whereas the social vulnerability approach starts by assessing vulnerabilities already embedded in a given social context.

FIGURE 1 | Key spheres underlying concept of vulnerability



Source: Birkmann 2005: 4

Defining features of vulnerability

- Vulnerability is a differential concept because risks or changes and abilities to cope vary across physical space and among and within social groups.
- Vulnerability is scale-dependent, both across time and space: it varies according to the unit of analysis, i.e. individual/household/community/region/system.
- Vulnerability is dynamic: characteristics that shape vulnerability change over time.

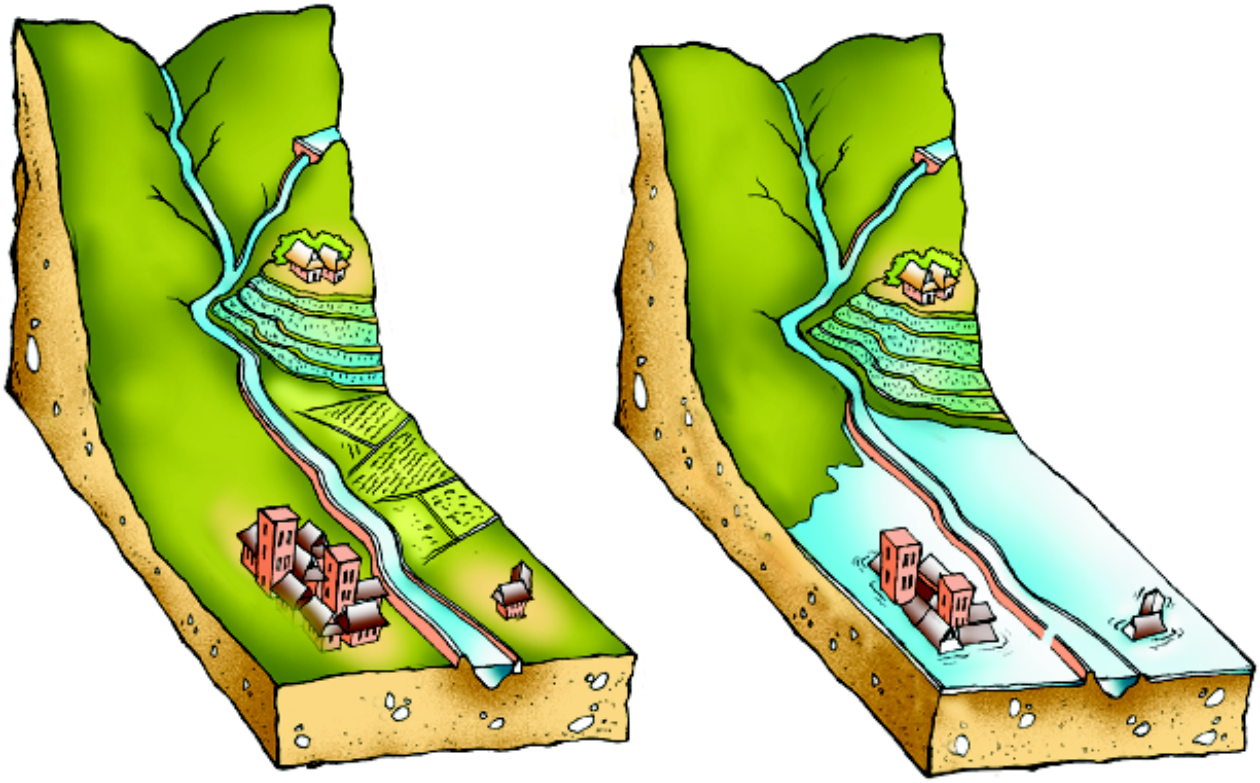
(Adapted from Vogel and O'Brien 2004)

- Governance and decision-making (conflict resolution)

Psychological/Attitudinal:

- Resistance towards change
- Dependency, trauma (or lack of social / physical mobility)
- Lack of self-autonomy

Given the above context, the working definition of vulnerability for the multiple case studies conducted by this consortium, following Cutter (1996), Mustafa (1998) and Adger (2006) is, as a condition that makes individuals, groups, and social systems susceptible to suffer harm from environmental extremes and that they are relatively less able to recover from that harm.



Embanked river

Breached embankment

Source: Dixit (2002)

Aspects of Social Vulnerability in South Asia

Poverty and Vulnerability

> Today's poverty is yesterday's unaddressed vulnerability.
>
> (Yamin *et al.*, 2005: 5)

Vulnerability is different from poverty, though the terms are often used synonymously. Poverty typically measures the *current* status of deprivation, lack or want, for example, the lack of access to resources (material, political, cultural) and the capacities necessary for full participation in economic and social life. Vulnerability, on the other hand, is a more *dynamic* concept than poverty, which is seen as a 'static' state, caused largely, but not only, by income deprivation. In that sense *poverty* is yesterday's unaddressed vulnerability as it captures the changing degree of defenselessness, insecurity or susceptibility to loss caused by exposure to disaster, shocks or unequal risk of individuals, communities and systems. 'Vulnerability is manifested in the uncertainties surrounding the survival strategies of the poor, their lack of capacity to cope with crisis as well as the seasonal dimensions of poverty', (Murthy and Rao, 1997: 12).

Poverty is a core dimension of vulnerability: All poor people are vulnerable, but not all vulnerable people are poor (ActionAid, 2005: 7). That is, the rich are also affected by disasters. For example, the urban middle class in Ahmedabad (Gujarat earthquake, 2001) or upper middle class in the Margala Tower in Islamabad (Kashmir earthquake, 2005) or coastal Thailand or New Orleans (Tsunami 2004, Hurricane Katrina, 2005) were affected, but their ability to respond, find shelter and alternative livelihoods if necessary is significantly higher as they have reserves and insurance to fall back on. It can also be argued that the rich have more choices – they may 'choose' to live in beautiful, but fragile and hazard-prone mountain environments, whereas the poor have little access to alternative security mechanisms or safety nets (except for family, kin relations) and are pushed into slums (a 'livelihood resource') or to live on and cultivate slopes prone to landslides (Wisner *et al.*, 2004: 13).

On the other hand, as our earlier research on adaptive strategies in South Asia has illustrated (Moench and Dixit eds., 2004), middle-income farmers in northern Gujarat are often as, or even more, vulnerable than small and marginal farmers when severe climate-water disasters (drought) occur as the latter have diversified their livelihood strategies:

'Middle income farmers often practice extremely intensive forms of agriculture that depend heavily on access to regular water supplies and on a narrow range of crop varieties. While such systems can improve living standards *(albeit, in the short term)*, middle-income groups are often unable to accumulate substantial capital reserves. Because their livelihoods are somewhat buffered from normal fluctuations through access to

resources such as groundwater, they often lack the incentives to invest in education and other forms of diversification. Furthermore, because they do not have to cope with serious fluctuations in income on a regular basis, they are often unfamiliar with labour markets and migrating to obtain work during periods of crisis *(limited, if any, livelihood diversification)*. As a result, they can be even more vulnerable than the poor or other marginal communities when serious disruptions occur,'
(Moench and Dixit, 2004: 17, italics added).

Vulnerability in South Asia should be seen in the context of the opportunities and risks posed by globalisation and also intersections with other dimensions of social exclusion, such as gender, caste and, increasingly, religion.

Vulnerability in South Asia should be seen in the context of the opportunities and risks posed by globalisation on the one hand, and on the other, its intersections with other dimensions of social exclusion, such as gender, caste and, increasingly, religion. Technological and economic globalisation processes are intensifying and, in combination with demographic growth, increasing consumption and climate change, altering livelihood systems. The livelihoods of the vulnerable sections of the population, particularly the poor, are in the process undergoing fundamental changes that often increase their vulnerability.

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Women participants in 2006 local level SLD in Nepal.

Gender and Vulnerability[1]

In the context of South Asia, and indeed in most parts of the world, it is well recognised that poor women, children and the elderly carry disproportionate 'vulnerability bundles' which places them in the highest risk category, even amongst marginalised communities and the poor (Ariyabandu and Wickramasinghe, 2003; Fernando and Fernando, 1997). Writing in the now classic text 'At Risk' more than a decade ago, Wisner *et al.* (1994, 2004) acknowledge that vulnerability is structured by relations of gender and power intersecting at different institutional sites.

Gender here is understood as the socially constructed identities, roles and responsibilities of women and men, and the relationship between them. Gender relations are embedded in specific social and cultural contexts and are dynamic, characterised by both conflict and co-operation, and mediated by other axes of social stratification. Gender inequality is not a homogenous phenomenon and disasters can affect different social groups of women or girls as differently

[1] This section draws on Ahmed (2006)

as they may do different social groups of men or boys. While there is limited gender desegregated data on disaster-related mortality, emerging evidence, for example from the tsunami (2004) or the recent earthquakes in South Asia (Kutch, 2001 and Kashmir, 2005), suggest that women and children are the primary casualties. This is because disasters accentuate existing asymmetries of power, impoverishing women further, leaving them more insecure in the face of adversity. In a group discussion in the flood, and increasingly drought prone, village of Sonatikar in Gorakhpur District, Eastern Uttar Pradesh, women described their vulnerability to food insecurity with the following simple phrase: 'half full stomachs' (Focus group discussion, Gorakhpur, November 2006). Despite new policies and laws most rural and urban poor women continue to lack access to (or ownership / control over):

- productive resources such as land, water, labour and credit (lack of entitlements) given the increasing privatisation and or degradation of common property resources
- employment and other income-generating opportunities
- opportunities that can build their skills and capacities such as education, or ensure a better quality of life (health-care, adequate food and nutrition, access to water, sanitation and hygiene)
- to participation in decision making and governance at different institutional levels because of social norms which define women's mobility (seclusion) or question the nature of her participation in societal processes

Women are often the primary victims of increasing domestic violence and social conflicts in societies where the politics of gender and identity intersect with communalism, fundamentalism and terrorism to shape women's lived experiences. In a disaster context, women's entitlements and perceptions of interest and well-being (Sen, 1980) are further contested as households struggle to survive: 'Women themselves underestimate the enormous range of burdens they bear, they may harbour negative images about themselves and be unused to perceiving of themselves as strong and effective survivors, managing a wide spectrum of household and social responsibilities,' (Parasuraman and Unnikrishnan, 2000: 11).

Caste and Vulnerability

The complex social hierarchy of caste which characterises community relations in India and Nepal determines not only who has access to 'common' resources such as water, but equally where people live in a village community and the kind of educations, livelihoods and other entitlements they have access to. The principle of social stratification embodied in caste dates back to the Vedic period (about 4,000 years ago) and defines inherited (at birth) and fairly rigid hierarchies of social occupation, status and mobility.[2]

Lower caste communities, so defined by the polluting nature of their occupational identity, have separate wells, often further away, and are not allowed to draw water from the public / village well or hand pump –

Gender relations are dynamic, characterised by both conflict and co-operation, and mediated by other axis of stratification including caste, class, race, ethnicity, physical or mental ability, age and marital status or position in the family.

[2] For a more detailed discussion on caste in South Asia see Fuller (1997)

Caste, gender and identity determines access to educational and livelihood opportunities and thus influence vulnerability.

though they can access well water if someone fills up their pot. During periods of scarcity, if there is no water in the village well, upper castes often 'claim' the wells of the lower castes through ritually purifying acts (Joshi and Fawcett, 2005). Caste hierarchies intersect with gender to control women's mobility and social conduct and exclude them from certain water sources when they are considered to be 'polluting' – typically during menstruation or after childbirth. Thus, lower caste women face the triple burden of caste, gender and poverty – stories of the sexual harassment of *dalit* (scheduled castes) women when they are forced to walk further to collect water during drought are not uncommon, as they are left alone without the support of their men who have migrated in search of work (Ahmed, 2005). On the other hand, in the upper caste communities of Gujarat – the Darbars – men do not let their women go out of the village to collect water, not for any altruistic reasons but because of the practice of female seclusion or *purdah*. Such caste and gender norms of seclusion also constrain women's participation in community decision-making forums and separate spaces such as women's self-help groups (SHGs) are important for not only facilitating empowerment, but equally sharing information on disaster risk reduction.

Caste also determines access to educational and livelihood opportunities which can help people move out of vulnerability and facilitate adaptation – however, positive discrimination policies in India (quotas for caste-based reservation in academic institutes and the work-place) are controversial as the current impasse between the legislative and judiciary wings of the state illustrates.[3] On the other hand, the perceived or constructed rigidity of certain caste based occupations, such as fishing, is also restrictive towards livelihood diversification. Despite declining fish-stocks and increasing disaster risks, fishermen in the tsunami affected coastal village of Vanatagiri in Nagapattinam District, Tamilnadu, preferred not to move out or diversify their livelihood strategies: 'We have no other skills – this is what our ancestors have been doing for generations and this is the only thing we know,' they claimed (Focus group discussion with fishing community, December, 2006). While the quote illustrates psychological and real skill level barriers to occupational mobility, it also shows the intersection of livelihood with identity, perhaps even a cherished identity–caste and occupation driven identity too can be a driver of vulnerability.

The Social Construction of Vulnerability

Our understanding of the everyday dimensions of vulnerability is not only based on the material reality of people's lives, but also on their perceptions or the social construction of their reality. *How do individuals, women and men, and communities collectively create and uphold social constructions that direct, limit and/or enable adaptive behaviour as well as influence perceptions of their reality* (Löf, 2006: 15)? Such a social constructionist

[3] Currently, the Union government wants to pass legislation to reserve seats in academic institutions for backward communities, but the Supreme Court has questioned the rationale of this process and effectively stayed it.

perspective becomes critical when trying to understand differential vulnerability and coping capacities which are as much based on physical material reality and enabling social or institutional structures as they are on people's perceptions of their agency. Post-modernists and social constructionists would argue that knowledge of reality by definition is socially constructed and cannot be divorced from social experience or accessed objectively. Berger and Luckmann (1987: 13) define 'reality' 'as a quality pertaining to phenomena that we recognise as having a being independent of our own volition (we cannot 'wish them away'), and ... 'knowledge' as the certainty that phenomenon are real and that they possess specific characteristics', (cited in Löf, 2006: 17).

But some would argue that constructionist approaches need to be handled with care as relegating everything to people's subjective perceptions or their 'ways of seeing' and defining what is 'objective reality' (i.e. climate change) is like throwing the baby out with the bath water as it does not help us move the agenda of practice on disaster mitigation or climate adaptation forward (see Wisner *et al.*, 2004: 19). However, the question is not whether climate change, for example, exists or not – there is enough scientific evidence and indigenous knowledge / reflection on the impacts of changing climate and weather patterns – but to dig deep into differential (subjective) understandings or perceptions of lived and experienced climate change reality.

Terminological and inter-disciplinary differences notwithstanding, what is needed is a better conceptualisation of the lived reality of vulnerability to climate change and the potential of adaptation processes which can then feed into wider policy debates.

Young girls collecting rice distributed by relief agencies during 2007 floods in Eastern Uttar-Pradesh

Capacities and Capabilities: the Other Side of Vulnerability

> Development is the process by which vulnerabilities are reduced and capacities increased.
> (Anderson and Woodrow, 1988)

Capacities are the characteristics of communities and people which can be used to respond to and cope with disasters.

Capacities are the characteristics of communities and people which can be used to respond to and cope with disasters. The use of the concept of capacity emerged in response to the supposed negativity of the term vulnerability which suggested that people were passive victims rather than recognising the many inherent capacities that make them competent to resist hazards (Cannon *et al.*, 2003: 7).[4] These can include group or institutional membership, mobility, literacy or timely access to resources such as credit and insurance. Capacities and vulnerabilities are not necessarily at opposite ends of the disaster spectrum, that is, high vulnerability does not equal low capacity per se. For example, someone with a low nutritional or poor health status may be an active community mobiliser in a disaster context–her physical capacity may be poor, but her social capacity is high. On the other hand, someone's capacity may make others vulnerable. For example, a rich farmer with the capacity or resources to access water (takes a loan to dig his tube well deeper) may be depriving others from accessing water because the groundwater level is deepened. Capacities, like vulnerability, need to be across spatial scales–from household to community to higher scales.

In the coastal areas, both Tamilnadu and Gujarat, one of the biggest gender differentiated capacities that came out in the various group discussions was the ability of most men, particularly the youth, to swim. Women, in contrast, are simply not taught to swim and their traditional clothes would actually be constricting when there is a storm, flood or cyclone and they have to escape to higher grounds.[5] This social norm is however being challenged in some of the post-tsunami rehabilitation work by NGOs who are teaching young girls to swim. Perhaps the biggest collective capacity in all the field areas remains social networks of extended families, friends and kin – when there is a crisis those who are affected borrow money or other necessities from those who are relatively better off. Although some of these informal social networks are being 'replaced' by new institutions such as the SHGs, these only meet partial needs for credit and in most cases, do not reach the poorest or most vulnerable.

[4] The notion of capacities has its roots in the capabilities approach pioneered by Amartya Sen, Martha Nussbaum (2002) and others which puts forward a moral argument for the exercise of capacity rooted in notions of human dignity, rights and justice. It is at the core of the human development index and UNDP's Human Development Reports.

[5] The ability to swim is unlikely to be very useful in the event of a tsunami but this public impression speaks to the sense of efficacy that such a skill may impart, particularly perhaps in the aftermath of flood disaster for rescue.

Operationalising Vulnerability: the Problem of Measurement

> We are dealing with a paradox: we aim to measure vulnerability but we cannot define it precisely.
>
> (Birkmann, 2005)

Given the various approaches, definitions and multiple dimensions of vulnerability, can we really measure who is vulnerable – and vulnerable to what? Since vulnerability is a relative term, analysis while based on past hazard / disaster events can only be, at best, predictive (*likely* susceptibility). However, if vulnerability is viewed as a dynamic process which takes into account not only the risk of exposure and susceptibility, but equally, assesses the strength of different response strategies and / or the (relative) potential for these, then we may have a better indicator of who is vulnerable, when and how, as well as look at points of leverage for addressing vulnerability, building resilience.

As a starting point, it is important to distinguish between impact assessments and vulnerability assessment. Traditionally, impact assessments have been used to identify responses to risk and have typically focused on downstream impacts or potential consequences, both bio-physical and socio-economic, of environmental change. Impact assessments are used by a variety of national and international agencies, including the IPCC, to track the residual impacts of a particular event (e.g. drought) or human action (e.g. construction of a large dam) either from an ecosystem or social perspective (Vogel and O'Brien, 2004). In contrast, vulnerability assessments take into account the factors, both environmental and human, that together or separately, drive and shape the vulnerability of the receptor (e.g. a community or a landscape). The potential risks for either a specific social group, or community or ecosystem are assessed given a variety of stress events (multi-hazards) over time and in the face of the ability of society and the environment to respond (i.e. internal coping dimension). Thus, both external exposure and internal coping capacity are important in assessing vulnerability and risk (Vogel and O'Brien, 2004).

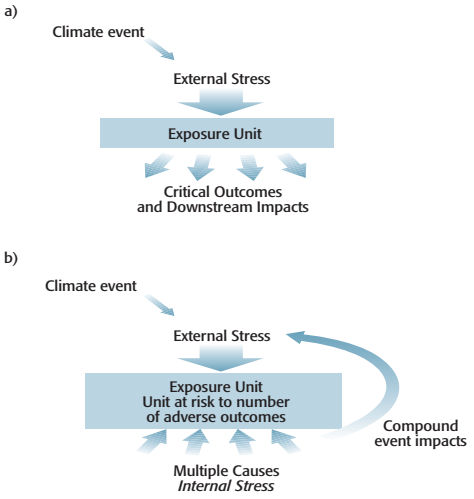
Typically, approaches to vulnerability assessment range from the establishment of quantitative indicators

Understanding drought: from impact assessment to vulnerability assessments

'The example of drought can be used to illustrate the difference between **impact** assessments and **vulnerability** assessments. On the one hand, drought in a region is usually driven by rainfall failure and higher than average temperatures associated with changes in atmospheric dynamics. An impact assessment, using climate variability as cause, usually then focuses on the consequences of this drought for various sectors, most notably crop production and agricultural income. On the other hand, the region's vulnerability to drought may be influenced by years of environmental degradation, past or present economic policies (e.g. *'green revolution' strategies that encouraged extensive ground and surface water withdrawal in agrarian South Asia*), and erosion of social capital and intricate support mechanisms over time. In some areas, conflict and war *(e.g. sub-Saharan Africa)* may further compound vulnerability to drought. The exposure unit (ecosystem and/or social group) thus is weakened by a set of drivers or causal mechanisms that together with the climate hazard contributes to the vulnerability of that community/*region*.'

(Vogel and O'Brien, 2004: 3, words in italics added)

FIGURE 2 | From (a) impact assessments to (b) vulnerability assessments



Source: Vogel and O'Brien, 2004: 2

If vulnerability is viewed as a dynamic process, then we may have a better indicator of who is vulnerable.

at different scales to qualitative narratives of socio-ecological change and coping / adaptive mechanisms. However, each has their own limitations.

The Indicator Approach: Quantifying Vulnerability?

Indicators are a means of encapsulating complex reality in a single, quantifiable or measurable and comparative construct (Vincent, 2004). The Hyogo Framework for Action (2005) called for the development of indicators as a key activity in disaster risk reduction:

> Develop systems of indicators of disaster risk and vulnerability at national and sub-national scales that will enable decision-makers to assess the impact of disasters on social, economic and environmental conditions and disseminate the results to decision-makers, the public and populations at risk.
>
> (cited in Birkmann, 2005)

Since vulnerability assessments can entail a considerable degree of uncertainty, indicators of vulnerability too are, at best, proxies for the various social, economic, environmental, physical, institutional, etc… dimensions of vulnerability. Such indicators are typically only available at a macro-scale of regions, countries, states and districts rather than the local level where planning and projects actually take place. Global risk index projects use a variety of data on hazards, climate (rainfall), demographic and economic patterns to map the likely vulnerability of different sectors, e.g. agriculture, tourism, industry, housing and infrastructure (assets at risk approach), again at a macro scale.

At the meso and micro level of the case studies that we are conducting we have developed a quantitative vulnerability index. The matrix, following the structure of the qualitative vulnerability analysis is an attempt at balancing the concern with susceptibility to suffer damage with the ability to recover from that damage. The matrix also draws attention to non-material–institutional and attitudinal aspects of vulnerability following Woodrow and Anderson (1989). Furthermore, the matrix balances local level perceptions from the field with expert assessments of costs and benefits as well as vulnerabilities and capacities that the field team members may bring to the exercise.

The matrix limits the field teams to no more than ten most significant factors when assessing vulnerability. Theoretically there can be an infinite number of factors that contribute to vulnerabilities and capacities. This

rather parsimonious model draws upon the discussion of the drivers of vulnerability in the literature to tease out the universally accepted most critical aspects (Adger, 2006; Wisner *et. al.*, 2004). There may also be some modification of the schema between individual level and community level vulnerability. Scores are attached to categories of vulnerabilities assessed at the local level. These scores are theoretically driven and are consistent with what have been identified as critical vulnerabilities in the literature. The scores are 1-10 with ten being the maximum value. One can balance off vulnerabilities and capacities by subtracting the capacities score from the vulnerability score as outlined in the index.

The index schema is designed with household surveys in mind, but they could be easily scaled up to the community or regional level, as long as the weighting given to different factors is finalised. Furthermore, the index schema is not meant to be a data collection tool but rather a data organisation tool.

Material Vulnerabilities

1. **Income source:**
   If 100% dependent on a local level productive asset, e.g. land, fishing, shop etc. then 10.
   If 50% dependent on a local level productive asset then 5.

   Lower the vulnerability grade for every 10% of non-local income reported by the survey respondents. Put a multiplier of 1.5 on the capacity if the income source is stable, e.g., govt. employment and insensitive to the local hazard. Conversely, put a multiplier of 1.5 on the income source on the vulnerability side if it is unstable and sensitive to the local hazard, e.g. day labor.

2. **Educational Attainment:**
   If no member of the household is literate, then vulnerability is 7.

   Lower the vulnerability score by 1 for every five years of schooling for the most educated male member of the household. Lower it by 2 for every female members' five years of schooling.

3. **Assets:**
   If none of the assets are immediately fungible, e.g. farm implements, household items, then vulnerability score would be 10.

   Lower the score by 1 for every Rs. 10,000 (or 20,000) of fungible assets, e.g., tractor, farm animals, savings, jewelry etc. (may be one of the more difficult data to be procured and one would have to derive the monetary amount empirically).

4. **Exposure:**
   Distance from the source of the hazard, e.g. river, coastline, landslide zones etc. If in close proximity or equivalent of 10 year flood plain, then vulnerability is 10.
   Lower the score by 1 for the equivalent of every 10 years flood plain residence and / or assets.

   Also, lower the score by 1 for every piece of evidence of hazard proofing for the assets, e.g. building of a house on a higher plinth for floods, light construction for earthquakes, low cost construction, which could be rebuilt with local resources, etc.

Indicators are a means of encapsulating complex reality in a single, quantifiable or measurable and comparative construct.

Quantitative measures supplement rather than substitute for qualitative assessments of vulnerability.

Institutional Vulnerability

5. **Social Networks:**
   Membership of ethnic, caste, professional or religious organisation or grouping and the local perception of the efficacy of the organisation or grouping. If none then vulnerability score would be 10.

   This could be true of recent immigrants to a community or repressed minority households. Lower the vulnerability score by 2 for every instance of past assistance by a group / organisation in adversity. The lowering will be per group or organisation. If multiple then lower it multiple times.

6. **Extra local kinship ties:**
   If there are no extra local kinship or other ties which could be a possible source of shelter and assistance during adversity, then the vulnerability score is 7.

   Lower the score by 2 for every immediate family member living extra locally, e.g. brother, sister, son etc. Lower it by 1 for every non-immediate family member living extra locally who could be a source of shelter.

7. **Infrastructure:**
   Lack of an all weather road: 4
   If seasonal road: 2
   Lack of electricity: 2
   Lack of clean drinking water: 4
   Lack of telecommunications: 4
   Lack of medical facilities: 4

8. **Proportion of dependents in a household:**
   If the proportion is greater than 50%, then 5.

   Lower the number by 1 for every additional earning member.

   If a single parent headed household, then 10.

9. **Warning systems**
   Lack of a warning system: 8
   Warning system exists but people are not aware of it or don't trust it: 5

Attitudinal Vulnerability

10. **Sense of empowerment:**
    Self declared community leadership: 10
    Proximity to community leadership: 10
    Proximity to regional leadership structure: 10
    Proximity to national leadership structure: 20
    Lack of access to community leadership: 10
    Lack of access to regional leadership: 5
    Membership of disadvantaged lower caste, religious or ethnic minority: 5

    Maximum possible vulnerability score being: 120

All of the above numbers could be adjusted through a shared learning dialogue with the communities and according to the circumstances. The number 120 could be discounted down to an index of 1-10. We could empirically derive the very high, high, moderate and low levels of vulnerability as the field study results come in. The schema is already being tested in the Muzaffarabad and Lai field sites in Pakistan and will be modified in light of the empirical findings. Hopefully, as we test this schema further, it will help us achieve the elusive goal of comparability of vulnerability across different field sites. This quantitative measure is not

meant to be instead of the narrative qualitative assessments, but rather to complement them. It is to the qualitative narrative type vulnerability assessments that we now turn.

Qualitative Narratives

In contrast to purely quantitative approaches, several academics and development practitioners believe in the potential of qualitative, actor-oriented or self-assessments of vulnerability. 'Story-telling' for some is a powerful methodology for unpacking the narratives, actions and agency of different stakeholders (Wisner, 2005). Development research routinely interrogates daily lives and livelihoods of the poor through a range of participatory and semi-structured methodologies. A 'story' in this context, is essentially an account of an experience of hazards (in normal daily life), e.g. community's experience of the changing availability and quality of their water or of a disaster event (earthquake, flood, volcano). They help distil how patterns of coping or adapting have changed over time or through different generations: What did your parents do when there was a cyclone or drought (e.g. migrate)?; What are you doing now (livelihood diversification)? and What do you hope your children will do when the next drought comes?

Stories are free-form narratives and can be related orally or through drawings (indigenous or folk art), maps (time-lines) and video-films. In many societies, stories form part of a tradition of passing knowledge on to the next generation and of recording and 'safe-keeping' change through different media (from cave paintings to the aboriginal art of 'dreaming' to digital technology). Stories can also be self-empowering and healing – many of the approaches in post-disaster trauma counselling use story-telling (re-call) as a form of narrative or through drawings recreating the disaster event, to help people cope with their immediate loss, their pain and grief, but also understand what makes them vulnerable.

Quantitative or qualitative assessments are not mutually exclusive – it depends on the scale of the analysis and on the focus or larger goal of the vulnerability assessment. For example, quantitative approaches, based on global or national data sets are useful for measuring vulnerability with regard to experienced losses – such as mortality or economic

Women's differential experience of floods in Gorakhpur

Kalavati, an upper caste woman, describes how she barely survived the terrible floods of 1998, the worst in the present living memory for most villages in Gorakhpur district:

'I was all alone with my two younger sons, my daughter-in-law and my little grandson, just two months old. My husband and eldest son had gone to work in Gujarat so I was responsible for everyone in the family. I took them to the village across the river in a boat and we stayed with the family of a religious man till the waters abated. Then I sent my daughter-in-law and grandson to Gujarat with my middle son, and I and my younger boy, just 15 years old at the time, went back to look after our house, or rather what was left of it. We had lost our entire house and two cows, so we had to stay in a temporary shelter with plastic roofing. I remember being very sick at the time, I had high fever and vomiting, so my neighbours helped me with food. Even my little boy was not well – something had bitten his hand in the flood waters and it had all swollen up. But he still looked after me as best as he could.'

Adhari from the *kevat* or boatmen's community describes how she suffered the impact of periodic floods in the absence of her husband who had migrated:

'In those days we had to pay a lagaan – land tax – to the local zamindar (landlord) of Rs 20/bigha. However, when the floods came and ruined our crops we were simply unable to pay this tax. So the zamindar's henchmen would tie five of us women together by our hair and make us carry heavy bricks on our back around the village for almost two hours as a punishment. I remember this happened to me at least four to six times,' described Adhari her eyes moist as she pulled her hair to show us how they were tied together.

Source: Ahmed forthcoming (2007)

A narrative helps distil how patterns of coping or adapting have changed over time or through different generations.

losses (crop yield, infrastructure, assets), but they are limited when it comes to measuring context-dependent and spatially specific characteristics (Birkmann, 2005). For their part, qualitative approaches are also limited as they tend to lack continuous assessments and are often used on a one-off basis and sometimes seen as just 'anecdotal' case stories which cannot draw-out any generalisable or comparable insights and are difficult to scale-up (far more consuming of time and human resource).

A combination of quantitative and qualitative tools are required to understand and measure vulnerability.

We believe that you need a combination of quantitative and qualitative tools to understand and measure vulnerability, which not only help in designing appropriate risk reduction and adaptation plans, but equally facilitate a continuous community-based self-reflective learning and participatory monitoring process. In the 1970s and 80s, disaster researchers began to look at people's experience of disasters to better understand the development context (social, economic, political, environmental) underlying disasters which made some people / communities more vulnerable than others. The first framework to help relief agencies understand pre-existing vulnerabilities and capacities of disaster prone communities was developed by Mary Anderson and Peter Woodrow (Anderson and Woodrow, 1989). Subsequently, there have been attempts to introduce the concept of vulnerability into other frameworks such as the sustainable livelihoods framework (Cannon *et al.*, 2003), the Pressure and Release Model (Wisner *et al*., 1994) and CARE's Household Livelihood Security Assessment.[6]

The starting point for understanding vulnerability in our project was the need for an integrative approach that was going to look at both the physical (external hazard / risk) and social dimensions (internal susceptibility / coping of different groups) of vulnerability at different levels / scales in each area – from disaster prone hamlets to the village to the district and region (e.g. coastal south Gujarat and Tamilnadu, flood / drought prone basins of Rohini and Bagmati rivers in Nepal, Eastern Uttar Pradesh and Bihar). Vulnerability assessments were primarily, but not exclusively, based on the Capacity and Vulnerability Analysis framework (CVA and variants – Participatory / Social Vulnerability Analysis) and were combined with other methodologies such as physical assessments of environmental or ecosystems services (forestry, agriculture, fishing, animal husbandry, watershed) and of communication and information systems. In addition, we used shared learning dialogues (SLD's) to understand the context of disasters, the different dimensions of vulnerability and climate variability, the potential of alternative disaster risk reduction mechanisms as well as the perceptions or social construction of disaster and 'agency' by diverse social actors. Here we focus on the vulnerability assessment process and tools. For more on the shared learning dialogues as a methodology, see Chapter 5.

Typically, there are three parts to a vulnerability assessment at the community level:

- **Mapping exposure to climate hazards** – the physical, ecological

[6] For a detailed analysis of the potential of these different frameworks, see Cannon *et al.,* 2003.

mapping of different risks and potential hazards

- **Understanding system sensitivity** – the extent to which the system will be affected (differential vulnerabilities, physical and social space, structures)
- **Assessing adaptive capacity** – the ability to cope, re-organise and minimise loss at different levels (system resilience, perception / motivation of actors)

Our objective was to link vulnerability analysis to existing livelihood strategies, ecosystem services, physical and social infrastructure, including information and communication systems, to identify points of intervention where we could strengthen people's ability to adapt and build resilience through a process of transformative change.

The key challenge for us in a given community context was to identify specific vulnerable groups: *who* is vulnerable in relation to a particular hazard, e.g. *which* fishermen, or *which* women-headed households so that we could develop appropriate implementation pilots with limited resources. In addition, we wanted to look at how vulnerable groups perceived or constructed their vulnerability and the role of different external actors, risk factors and policies in determining vulnerability. While there are many vulnerability assessment frameworks, we refer to the process we adopted as a participatory vulnerability and capacity analysis, building on the CVA framework (Anderson and Woodrow, 1989), the VCA (IFRC, 1999), ActionAid's PVA tool and Oxfam's PCVA. In practice, most of these frameworks follow the same basic principles of participatory community based vulnerability and capacity assessment – only nomenclatures differ, albeit slightly.

Participatory Vulnerability and Capacity Analysis (PVCA)

> Participatory vulnerability assessment is a systematic process that involves communities and other stakeholders in an in-depth examination of their vulnerability, and at the same time empowers or motivates them to take appropriate actions.
>
> (ActionAid, 2005: 11)

The core principles of a participatory vulnerability and capacity assessment (PVCA) are:

- Recognition of active agency: Poor and marginalised groups must be involved in finding the solutions to the problems they face.
- PVCA is not an end in itself, but should form the basis for a continuous process of action and reflection as it is based on the understanding of people's vulnerability as dynamic (changing).
- PVCA is a diagnostic tool which provides analytical data to support better informed decisions on the planning and implementation of risk reduction measures.

For us the PVCA was essentially a community level process, supplemented by the SLDs at multiple levels, as the sources of and solutions to vulnerability are often located or controlled by factors operating at multiple levels and external to communities. We used the three categories identified in the CVA – the physical, social and motivational – but

A good, analytical pre-disaster assessment can provide a base-line for future monitoring and learning processes that can feed into climate adaptation policy frameworks.

FIGURE 3 | Vulnerabilities and capacities analysis matrix

	Vulnerabilities Men Women (of different socio-economic groups)	Capacities /Potential Men Women (of different socio-economic groups)
Physical/material What productive resources, skills, risks and hazards exist?		
Social/organisational What are the social relations, networks and organisations among people?		
Motivation/attitude How do people view their ability to facilitate change?		

Adapted from Anderson and Woodrow (1989) and ActionAid (2005).

tried to go beyond a community level assessment to understand gender, caste and other social exclusion dimensions which affect vulnerability and capacities.

In all the four field areas, partners broadly followed the following steps. (Specific methodologies are highlighted in each case study chapter.)

Step 1: Situational Analysis

Objectives:

- to identify external threats, e.g. risks, hazards and climate variability
- to broadly understand who is vulnerable, how are they coping / adapting

Tools used:

- *Historical profiles*: trends, disaster time-lines including impacts, coping strategies
- *Transect walks*: changes in land use, access to water resources
- *Seasonality calendars*: debt, hunger, fund (credit) flows (differential – gender, class and caste)
- *Community mapping*: access / control to natural / social resources
- *Hazard mapping*: multi-hazards, e.g. floods, cyclones, fire

Step 2: Analysis of Causes

Objectives:

- in-depth analysis of differential causes of vulnerability
- prioritisation of differential vulnerability (gender, social exclusion) at the community level

Tools used:

- Focus group discussions with vulnerable groups
- *Vulnerability ranking matrix:* The team in Nepal has developed and used a ranking matrix to access vulnerability. The key findings are summarised in Chapter 6.

Step 3: Assessing Capacities

Objective:

- to assess different individual / community capacities to cope or adapt in given social, institutional and governance context

Tools used:

- *Venn Diagram* – mapping community perceptions on their level of engagement with different agencies or individuals that provide disaster mitigation services

- *Focus group discussions* to understand rights and entitlements (to resources, skills, endowments) as well as social networks (capital / labour), physical infrastructure (e.g. cyclone shelters, embankments)

- *Shared Learning Dialogues* to explore perceptions of change (behaviour, attitudes, motivation) and the role of different actors, actions in reducing disaster risk.

It is clear from the steps listed out above that any VCA is a complex inter-disciplinary exercise requiring multiple skills of facilitation and quantitative / qualitative analysis to assess both symptoms and causes of vulnerability. While a PVCA is primarily a community level tool, it needs to be integrated with the analysis of vulnerability at different scales or levels. In addition, while it is typically a pre-disaster exercise, it needs to be followed up by post-disaster assessments – not only to track whether or not vulnerability has been reduced, but more importantly to critically assess which interventions have been useful points of leverage in reducing vulnerability. A good, analytical pre-disaster assessment can provide a base-line for future monitoring and learning processes that can feed into climate adaptation policy frameworks. However, '*there is minimal evidence of systematic vulnerability analysis in which the physical, economic and social data are comprehensively integrated together. Furthermore, where vulnerability assessment takes place, it is normally seen as a specific process in measuring what is certainly more tangible and static than all the complexities of people within communities which are undergoing dynamic change*' (Davis, 1994: 11, cited in Bankoff *et al.*, 2004,: 139).

Emerging Methodological Challenges from the PVCA

- Building conceptual perspective and understanding on vulnerability takes time:
  How does it differ from poverty or impact assessment?
  How do you capture the dynamic nature of vulnerability?
  How do you define it in different local languages?
- Facilitating vulnerability assessment:
  Strong inter-disciplinary skills for both quantitative and qualitative aspects
  Good conceptual understanding of different dimensions of vulnerability
- Analysis of field data and insights:
  Using an integrative framework that links community insights to different levels and scales of analysis

Emerging Field Insights on Differential Vulnerability and Capacities

Conclusion: Why Vulnerability Matters

Despite the uncertainty about the scale, nature and rate of climate change, there is little doubt that it is going to affect our lives, our environment and our children's future. However, the degree to which we will be affected varies tremendously and depends not only on our exposure to risk, but equally, to our welfare, our perceptions of risk and our capacity to cope or adapt. Vulnerability analysis points to the urgent need to understand the critical linkages between

COASTAL GUJARAT

Physical dimensions of vulnerability

Gujarat has the longest coastline (1,600 km) among all the Indian states, a coast which is rich in biodiversity but also highly prone to multi-hazards like, extreme cyclones, salinity intrusion, floods and drought. Salinity ingress affects nearly 30 per cent of the land area of the state and is increasing at the rate of 1.5 km per year affecting the soil and freshwater aquifers. Though the data on sea-level rise is debatable it is likely that even small rises will significantly increase storm surges and any coastal buffers (mangroves or reefs) as well as the direction of inundation.

While data on climate variability is mixed, cyclones are likely to increase in strength and intensity, though perhaps not in frequency. This may lead to more wind damage on structures and crops. There have also been some changes in rainfall patterns – short periods of intensive rainfall, often leading to floods, followed by significant gaps in the number of rainy days have characterised the monsoon over the last two years. This, in turn, impacts surface runoff, soil erosion and sedimentation of tanks making it more difficult to store water in small dams, and increasing the probability of flash floods. On the other hand, increase in summer temperatures and short heat wave conditions as well as shorter winter months and an increase in the mean winter temperatures could have a positive impact on vegetative cover and soil organic matter. This could be an important mechanism (a potential capacity) to reduce erosion, buffer storms and assist groundwater recharge.

Such anthropogenic factors are undermined by growing populations, urbanisation and the recent political demarcation

by the state of large coastal areas as Special Economic Zones for industrial development, posing a challenge to livelihood security and natural resource management interventions. Utthan (www.utthangujarat.org), an NGO which has been working in the region for more than a decade, has selected three villages in the coastal district of Bhavnagar, namely, Sartanpar, Tarasara and Katpar. These are all affected by periodic drought, salinity ingress, cyclones and water-logging during the monsoons when there are floods caused by intensive rainfall coupled with storm surges or high tides and little protection is afforded by the village embankments.

Social dimensions of vulnerability
Caste intersects with gender in all three villages to determine who is vulnerable, where they reside and their access to resources including communication and information systems. In Sartanpar village for example, the Pitha and Bhil communities (tribal groups) reside in low-lying, flood-prone areas on the outskirts of the village making it difficult for them to access relief or information on impending disasters. The village temple provides the only safe sanctuary for people during floods and cyclones, but space is limited and it is possible that the most marginalised communities are denied access at times.

Livelihood diversification and a shift from agriculture as the primary source of income to migration (local, seasonal and long-term) and other off-farm activities characterises the rural economy in all the villages. Women are amongst the most vulnerable, though their vulnerability varies according to their socio-economic group and access to entitlements – for women from small and marginal landholding families for example, where male migration is high, managing land in the absence of clear land titles or even joint ownership is difficult. Access to water for irrigation or credit and extension services is often tied to land ownership or land as collateral. Water supply systems are unreliable, insufficient and not accessible when the village is waterlogged. Access to early warning information is also gendered – given the nature of their work, women rarely have time to watch TV or listen to the radio and most mobile phones are owned by men. Moreover, none of the women can swim, whereas at least 40 per cent of the men can.

Apart from the village *panchayat*, temple-based organisations and some emerging women's self help groups for micro-credit and savings activities, there are no collective village institutions that can respond to climate variability and disasters. Fallback mechanisms include social networks, extended family support and dependence on moneylenders after a disaster event.

Scope and extent of capacities/potential for adaptation and disaster risk reduction Gujarat was the first state in India to establish a Disaster Management Authority (GSDMA) in February 2001, after the massive earthquake in Kutch. This was followed by a disaster management policy (2002) and the Gujarat State Disaster Management Act (2003). While this legislative framework is meant to provide an institutional base for assessing risks and vulnerabilities, developing mitigation strategies and building community capacity through decentralised village disaster management committees, its intersection with civil society actors is limited. Much preventive information meant for the public domain, for example, the state vulnerability atlas, is not accessible. With the support of UNDP, the state government has launched a Disaster Risk Management programme in 14 most hazard prone districts, 50 *talukas* (blocks) and 4,174 villages of the state for building awareness in local communities and decentralised institutions of governance. Disaster management plans have, in principle, been made for district, *taluka*, municipal and village levels but in practice they are ineffective for the following reasons:

- The committees formed by the government for disaster response are adhoc and do not go through any consultative or legitimisation processes at the village level. As a result, they are not effective when disaster strikes and speedy actions have to be taken.
- There is lack of coordination among the line departments, which makes it very difficult for effective functioning after a disaster event.
- Delegation of administrative power and financial decision-making to lower levels of the government machinery, which is required to take quick action and engage locally available resources is limited. For example, a *mamlatdar* (block level officer) may be able to hire a boat locally, but since payments are not timely boatmen are often reluctant to comply.
- No updating of the inventory of local resources and so information available is usually outdated and redundant. This is coupled by the fact that government data is hardly reliable.

Given the limitations of the top-down approaches, the GSDMA has begun recognising the need to work with or at least collaborate with (some) civil society actors on capacity building and participatory community disaster planning. Oxfam has produced a GIS based decision-support tool with active village level maps and 25 vulnerability indicators (including the sex ratio, access to education and health, agriculture, etc. based on Census, 2001) and information on post-disaster service providers (transport agencies, volunteers, medics). Oxfam, ActionAid, the International Red Cross and CARE are part of an inter-agency platform formed after the floods in 2005 devastated many parts of the state to look at disaster mitigation issues, review policy guidelines, promote SPHERE principles and facilitate networking amongst different actors/agencies. However, most of these initiatives are still framed in the language of disaster mitigation, addressing preparedness and post-disaster relief and rehabilitation, rather than locating 'disasters' in the everyday continuum of livelihoods. Oxfam has just launched a global programme in India, Ethiopia and Honduras with the goal to reach 1 million small and marginal farmers in 10 years to help them adapt to the growing impacts on agriculture, including climate change, through support for livelihood diversification, reduced input costs, improved market access and more equitable institutional mechanisms. But strategies that build local resilience need to be linked to the wider framework of disaster/adaptation governance.

Source: Author's field notes, Utthan reports 2006-07

society-nature from a multiplicity of approaches – positivist (biophysical vulnerability), political ecology / economy (social space, power relations) and social constructivist (different perceptions of reality). It is a complex, messy process and there is no blueprint approach; neither should vulnerability analysis be seen as an end in itself nor used as an instrumentalist tool in the name of participatory disaster planning and risk mitigation. By drawing attention to the heterogeneity of communities at risk, to the differential, yet intersecting, dimensions of vulnerability, poverty, gender and social exclusion, participatory vulnerability assessments can provide an analysis of transitions at different levels, in time and space. But unless these community based processes feed into larger discourse on climate change and adaptation, as illustrated by our shared learned dialogues, and vice versa, then we will continue to see communities at risk without understanding the potential for change embedded in social, political and economic reality. In the final analysis, an integrative and comprehensive vulnerability analysis has to provide the foundation for building strong, democratic and representative institutions for minimising disaster risk and facilitating better disaster governance at different levels.

Bibliography

ActionAid (2005) *Participatory Vulnerability Analysis: A Step by Step Guide for Field Staff*, London: ActionAid International.

Adger, W. N. (2006) 'Vulnerability' *Global Environmental Change* 16: 268-281.

Ahmed, S. (2006) 'Gender, Vulnerability and Disasters: Key Concerns for Policy and Practice', *Disaster and Development* 1(1): 165-177.

Ahmed, S. ed. (2005) *Flowing Upstream: Empowering Women through Water Management Initiatives in India*,' Ahmedabad: Centre for Environment Education and New Delhi: Foundation Books.

Anderson, M. and P. Woodrow (1989) *Rising from the Ashes: Development Strategies in Times of Disasters*, London: Westview Press.

Ariyabandu, M. M. and M. Wickramasinghe (2003) *Gender Dimensions in Disaster Management: A Guide for South Asia*, Colombo: Intermediate Technology Development Group.

Bankoff, G., G. Frerks and D. Hihorst (2004) *Mapping Vulnerability: Disasters, Development and People*. Earthscan: Sterling, VA.

Birkmann, J. (2005) 'Danger Need not Spell Disaster: But How Vulnerable are We?' UNU-EHS Research Brief No. 1.

Bohle, H.G, Downing, T.E., and M.J. Watts (1994) 'Climate change and social vulnerability', *Global Environmental Change* 4(1): 37-48.

Cannon, T., Twigg, J. and J. Rowell (2003) *Social Vulnerability, Sustainable Livelihoods and Disasters*, Report submitted to DFID, U.K.

Cutter, S. (1996) 'Vulnerability to Environmental Hazards', *Progress in Human Geography* 20(4): 529-539.

Dixit, A. (2002) *Basic Water Science*, Nepal Water Conservation Foundation, Nepal.

Enarson, E. and B.H. Morrow (eds.) (1998) *The Gendered Terrain of Disaster: Through Women's Eyes*. Westport, CT: Greenwood Publications.

Fernando, P. and V. Fernando (eds.) (1997) *South Asian Women: Facing Disasters, Securing Life*. Colombo: Intermediate Technology Publications for *Duryog Nivaran*.

Fordham, M. (1999) 'The intersection of gender and social class in disaster: balancing resilience and vulnerability,' *International Journal of Mass Emergencies and Disasters* 17(1): 15-36.

Fuller, C.J. ed. (1997) *Caste Today*, New Delhi: Oxford University Press.

Hilhorst, D. and G. Bankoff (2004) 'Introduction: Mapping Vulnerability', in G. Bankoff, G. Frerks and D. Hilhorst (eds.) *Mapping Vulnerability: Disasters, Development and People*, London: Earthscan.

Hyogo (2005) *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*, A/CONF.206/6, World Conference on Disasters Reduction, January 18-20, Kobe, Hyogo, Japan.

IFRC (1999) *Vulnerability and Capacity Assessment: An International Federation Guide*, International Federation of Red Cross and Red Crescent Societies, Geneva.

Joshi, D. and B. Fawcett (2005) 'The Role of Water in an Unequal Social Order in India', in A. Coles and T. Wallace eds. *Gender, Water and Development*, Oxford: Berg.

Löf, A. (2006) '*More than meets the eye? Exploring how social constructions impact adaptive capacity to climate change*', Unpublished Masters Thesis, Centre for Transdisciplinary Environmental Research, Stockholm University.

Moench, M. and A. Dixit eds. (2004) *Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for Responding to Floods and Drought in South Asia*, Kathmandu: Institute for Social and Environmental Transition, Nepal and Boulder: ISET-International.

Morrow, B.H. (1999) 'Identifying and mapping community vulnerability,' *Disasters* 23(1): 1-18.

Murthy, R.K. and N. Rao. (1997) *Addressing Poverty: Indian NGOs and their Capacity Enhancement in the 1990s*, New Delhi: Friedrich Ebert Stiftung.

Mustafa, D. (1998) 'Structural Causes of Vulnerability to Flood Hazard in Pakistan' *Economic Geography*, 74(3): 289-305.

Nussbaum, M.C. (2002) *Women and Human Development: The Capabilities Approach,* New Delhi: Kali for Women.

Parasuraman, S. and P.V. Unnikrishnan (2000) *India Disasters Report: Towards a Policy Initiative*. New Delhi: Oxford University Press.

Smith, A.O. (2004) 'Theorising Vulnerability in a Globalised World: A Political Ecology Perspective', in G. Bankoff *et al.,* eds. *Mapping Vulnerability*, London: Earthscan.

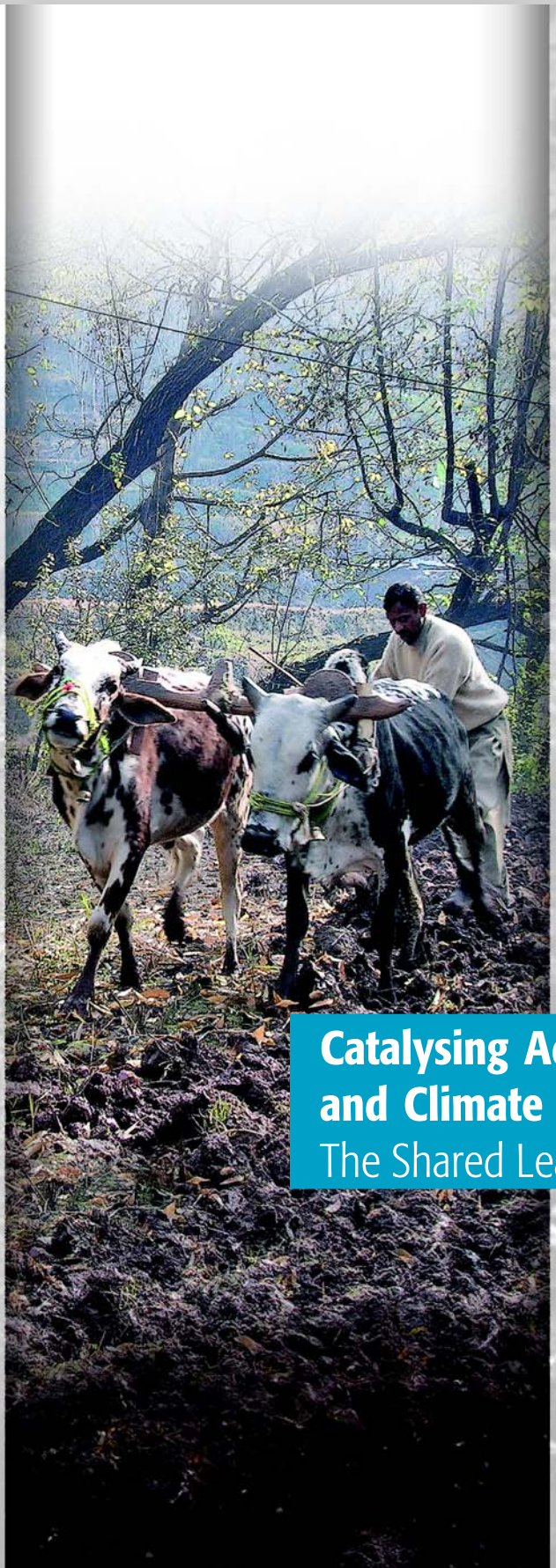
Vincent, K. (2004) Creating an Index of Social Vulnerability to Climate Change for Africa, Tyndall Centre for Climate Change Research, Working Paper #56, School of Environmental Sciences, University of East Anglia, Norwich.

Vogel, C. and K. O'Brien (2004) 'Vulnerability and Global Environmental Change: Rhetoric and Reality', AVISO, Issue No. 13.

Wisner, B., Blaikie, P., Cannon, T. and I. Davis eds. (1994 and 2004) *At Risk: Natural Hazards, People's Vulnerability and Disaster*, London and New York: Routledge.

Wisner, B. (2005) Author's notes from presentation made and discussions with Wisner at the IHDP Open Meeting, University of Bonn.

Yamin, F., Rahman, A. and S. Huq (2005) 'Vulnerability, adaptation and climate disasters: A conceptual overview,' *IDS Bulletin* 36(4): 1-14.



5

CHAPTER

Catalysing Adaptation to Disaster Risks and Climate Change:
The Shared Learning Dialogue Process

Sara Ahmed, Shashikant Chopde, Ajaya Dixit, S Janakrajan, Fawad Khan, Marcus Moench, Daanish Mustafa, Sarah Opitz-Stapleton and Shiraz A Wajih

The Need

The challenges inherent in reducing the risk of large scale disasters and catalysing social responses to climate change share an important characteristic – both involve events or conditions that may never have been previously experienced by the affected populations.

The gap between hazards or changes that are analytically 'known' and experience creates a social space in which perceptions regarding risks and potential strategies for responding to them multiply.

Disasters are recurrent events and from the biblical stories of the 'flood' to the daily news have played a major role in shaping known history. In some regions, extreme events of the type that can cause disasters recur with such sufficient frequency that they are embedded in the psychology and behaviour of populations. In many other regions, however, they are well beyond the types of human memory that shape daily behaviour. The average age of the population in Nepal at present (2007) is below 15 years. The last major earthquake in the Kathmandu valley that resulted in substantial direct disruption of life and property occurred in 1936. The Himalaya are known as one of the most earthquake prone regions in the world and major quakes occur in parts of the region every decade – but on a practical level most people in Kathmandu have never themselves experienced the tremendous destructive power earthquakes can generate and don't know anyone who has. At an analytical level, elements within society know the risks. The population sits on a time bomb – but the direct experience necessary to catalyse response is minimal. Furthermore, even where direct experience exists, the probability of events recurring in the same region within the time horizon most people base day to day activities on is highly unlikely.

The above is, in many ways, parallel to the challenge associated with climate change. Scientific evidence on the probable consequences of climate change is accumulating rapidly. People in many regions have experienced the effects of extreme storms and the types of climatic variability projected as a consequence of climate change. Elements of society know the risk and some have direct experience. That said, the risk appears intangible – a possible cloud sometime in the future, not something that should shape behaviour in the here and now.

The gap between hazards or changes that are analytically 'known' and experience creates a social space in which perceptions regarding risks and potential strategies for responding to them multiply. Local direct experience often provides little basis for populations to develop strategies for mitigating or otherwise responding to the types of risk associated with events – such as potential rises in sea-level – that have never been experienced. Community-driven strategies for responding to climate change and intermittent hazards have, as a result, inherent limitations. At the same time, the limitations of 'expert' perspectives have been soundly demonstrated by the dismal history of many top-down driven attempts toward regional development and hazard mitigation. Hazards are

local phenomenon. They are shaped by geography, institutions, infrastructure, social relationships, economic structures, politics and a myriad of other factors and processes operating within local and regional contexts. 'Expert knowledge,' may be able to quantify the frequency and probable magnitude of hazard events, but is unable to systematically capture the complex dynamics embedded in local situations.

In addition to the tensions between expert and local knowledge, tensions exist in the long history of research and applied work on international development and environmental management. This history is important to recognise because it captures the tensions and dilemmas inherent in designing strategies that respond to both existing disaster risks and those emerging as a consequence of climate change.

A Brief History

Ever since the beginning of what might be called the 'development era' in the post World War II period, tensions have existed between macro-perspectives and those emerging from the complex realities that shape local contexts. In India, the world views of Nehru and Gandhi, mythologies of centralised socialist development versus village, community and tradition represented competing narratives for the future. Initially, most development was conceptualised primarily as a process of modernisation – of delivering the knowledge, technologies and systems to local communities so that they could abandon the 'backward' traditional practices seen as hindering modern 'developed' ways of working. The 'Green Revolution' that transformed global agriculture was framed largely by this model. Centralised research institutes (the CGIAR system) developed modern seeds and packages of technologies. These were delivered to rural areas through agricultural extension services and replaced lower value (defined primarily in terms of production) traditional varieties. Support services, the dams and irrigation systems that Nehru, India's first Prime Minister, famously called the 'temples of modern India,' were built to support the new modern agriculture. Developed ways supplanted "backward" traditions. Losses in terms of genetic diversity and locally adapted varieties were rarely recognised.

During the 1960s and 1970s, research by anthropologists, sociologists and rural development practitioners building largely, on concepts from the Gandhian tradition, led to recognition of the central role indigenous technologies, modes of organisation, and cultural practices could play as major elements contributing to development. This recognition emerged at the same time as many centrally-driven programmes for development that had been designed based primarily on external 'expert' knowledge were failing or running into major problems. Local communities did not automatically 'adopt' the approaches promoted and, on further investigation, it was gradually recognised that this was often for very good reasons. The factors framing reality at local and global levels often diverge.

As recognition of local realities grew, the pendulum of approaches to the design of development programmes swung away from centrally driven and conceptualised strategies to efforts driven at the community level.

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community level. Participation emerged as a strategy to bring local inputs into what were still largely centrally driven and conceptualised processes. This was accompanied by techniques such as 'rapid rural appraisal' – which rapidly morphed into 'participatory rural appraisal' – for bringing local information into development planning. When this was recognised as weak (why should locals 'participate' in a process they had no role in defining?) concepts such as stakeholder 'ownership' and community-driven development emerged as avenues for strengthening the locally rooted nature of development processes. This was accompanied by many techniques to decentralise the design, implementation and control over development and natural resource based activities.

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Within formal government systems, core powers have often been devolved to local levels as, for example, with the *panchayat raj* in India. At the same time, numerous forms of local organisations from self-help groups to informal groups for disaster, forest, irrigation and other management activities have become centerpieces in development strategies. In some cases, as with Nepal's experiences in community forestry, decentralisation has generated huge successes. In other cases, a variety of factors – principally having to do with scale and macro-processes such as demographic trends – have undermined the viability of community-based strategies. When processes operate at scales greater than the local level and when large portions of the population migrate or commute long distances to work in activities that are not locally rooted, then communities lose their geographic definition and the logic underlying locally-based approaches declines. People residing in regions still have unique communities, networks and insights into local conditions but their ability to organise and influence the changing dynamics of increasingly globalised systems has inherent limitations.

The emergence of locally driven strategies and forms of organisation has not replaced centrally driven strategies. In many fields – such as water and disaster management – strategies operate in parallel and often in direct competition. The Water Ministry in India, for example, is currently developing a programme to link all rivers in the sub-continent. This massive infrastructure programme is a direct evolution from Nehru's almost religious vision of dams. Water will be provided to farmers which will modernise agriculture. The vision competes with equally ideological visions, initially rooted in Gandhian traditions and now embedded in many civil society organisation, of village development that focuses on the poorest of the poor. It is important to emphasise that this competition is as much *ideological* as it is strategic. The competition is as much driven by conflicting visions of what life *should be*, what the state *should do*, and *who should* drive development as it is about 'what works' in terms of improving living standards or the condition of basic resources.

The above history of development processes – the interplay between community-based and state-based strategies and ideologies – largely ignores the private sector. Throughout much of the history of international development, private sector actors have been treated as exogenous elements. They aren't treated as part of communities (despite the fact that they often represent a strong community of

interests). Except as elements to be hired for completion of a project (to build a dam) or to be manipulated and catalysed for service provision, the private sector often aren't incorporated in centrally driven strategies. Historically, the private sector has largely been ignored as an actor in the development process. More recently, however, the private sector, driven by a profit motive is being recognised as a key engine for generating new technologies, for creating jobs and for delivering key services.

As with centrally-driven and community-based strategies, perspectives on the behaviour and role of the private sector are characterised as much by conflicting ideologies as by actual evidence on 'what works' in meeting basic needs. This conflict is demonstrated by current widespread global debates over privatisation of service delivery organisations (such as water and power utilities). In a somewhat indirect manner, it is also characterised by tensions over migration – the appropriateness of individual 'private sector' actors moving to where jobs exist.

Organisational Logics & the Implications of History

The brief history outlined above was presented in order to make three core points that have direct relevance for the development of strategies for responding to climate change and that underpin the shared learning dialogue (SLD) methodology:

1. Perspectives on the role of different actors (states, communities and private sector organisations) are heavily influenced by conflicting and deeply embedded ideologies.
2. The organisational logic underlying different modes of organisation generates very different perspectives and response strategies in relation to perceived constraints and opportunities; and
3. None of the strategies that emerge in relation to the above modes of organisation can, by itself, address the challenges inherent in reducing disaster risk or responding to climate change.

Developing effective responses to the intermittent events that cause disaster and to evolving processes such as climate change, will require mechanisms for bridging the inherent tensions between different ideological perspectives. It will also require mechanisms for moving from embedded notions of '*what should be*' to more pragmatic recognition of '*what might be achieved*.' In addition to bridging ideological differences, this will require increased recognition of the organisational logic that underpins the strategies advocated and implemented by different actor sets.

Most centrally organised, state-driven approaches to development focus either on execution of activities or control over the activities of others. To put it another way, government organisations either play an executive role (they build and operate infrastructure, whether physical or for the generation of knowledge) or a regulatory role (they regulate the operation of markets, companies and community-based or civil society organisations). The operational logic of the State is inherently large-scale delivery and control oriented. Organisationally, it is far more difficult to implement numerous small distributed activities than larger programmes or projects. At the same time, states derive legitimacy

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and power through the benefits they deliver to key constituents (whether those represent the full population or a narrow elite) and their ability to maintain control. The strategies and types of activity likely to be advocated by states in response to climate and disaster risk will tend to reflect this organisational logic. Large-scale, often structural, programmes that build hard resilience (protect) regions are likely to be a common outcome.

Where climate change is concerned, the private sector is motivated largely by the risks and opportunities they perceive. The perceptions may be different, scientifically substantiated impacts.

Where disasters and the risks emerging as a consequence of climate change are concerned, the private sector is motivated largely by the risks and opportunities they perceive. In terms of their own operations, they will take steps to take advantage of potential business opportunities and to mitigate risks, particularly those that appear to present a short-term risk to their operations. Similar logic drives the operation of small business entities (individuals and households) as well as global corporations.

At the community level and within civil society, responses to disaster risks and those associated with climate change will be driven by the organisational logic of identity. This often translates into a political advocacy role – the application of pressure on the State to deliver services or meet needs. It can also translate into group-directed activities such as community-based disaster planning or the management of resources (from credit to ecosystems) at the local level. Activities of this type that involve long-term organisation and implementation rather than ephemeral issue-based advocacy. However, they generally require underpinning from either a public or private sector business model.

Globally, virtually all examples of community-based organisations that have survived over long time periods have a clear source of revenue. In some cases this is derived through a private sector business model (revenue from service provision or other goods), in some cases through a public sector business model (contributions in return for services, membership fees or taxes) and occasionally (as with some religions) through donations. The organisational logic of community-based organisations will tend to generate specific types of responses to climate and disaster related issues.

When events occur that bring risks to the forefront, then organisation for advocacy purposes will increase. Between such periods, activities that can be underpinned by a business model of some sort are also possible. Many such activities may support the building of soft resilience through activities such as education, local resource management or the provision of services that have immediate benefits for the community. These activities, in effect, provide an operational logic for the business model.

Toward Methodological Approaches for Shared Learning

In order to develop effective strategies for responding to disaster risks and the changes likely to occur as a consequence of climatic change, the gaps created by differences between expert and local knowledge and the differing ideological histories of development need to be bridged. This will need to occur over long time periods as knowledge on climate, risks and effective response strategies evolves. In addition, rather than focusing on strategies that emerge from one set of organisational logics, approaches capable of creating synergy between communities, the private sector and government actors working at different scales will be essential.

Bridging gaps such as the above requires shared learning – the iterative transfer of information and perspectives between communities and actor sets within regions and disciplines. While wide cultural gaps are inherent in any society, and no process for this can be completely effective, the shared learning dialogue process outlined below is intended as a key process for building common understanding and encouraging reflexive learning across scales, groups and styles of organisation. This creates a basis for action in response to the risks associated with climate change and other hazards.

The Conceptual Origin

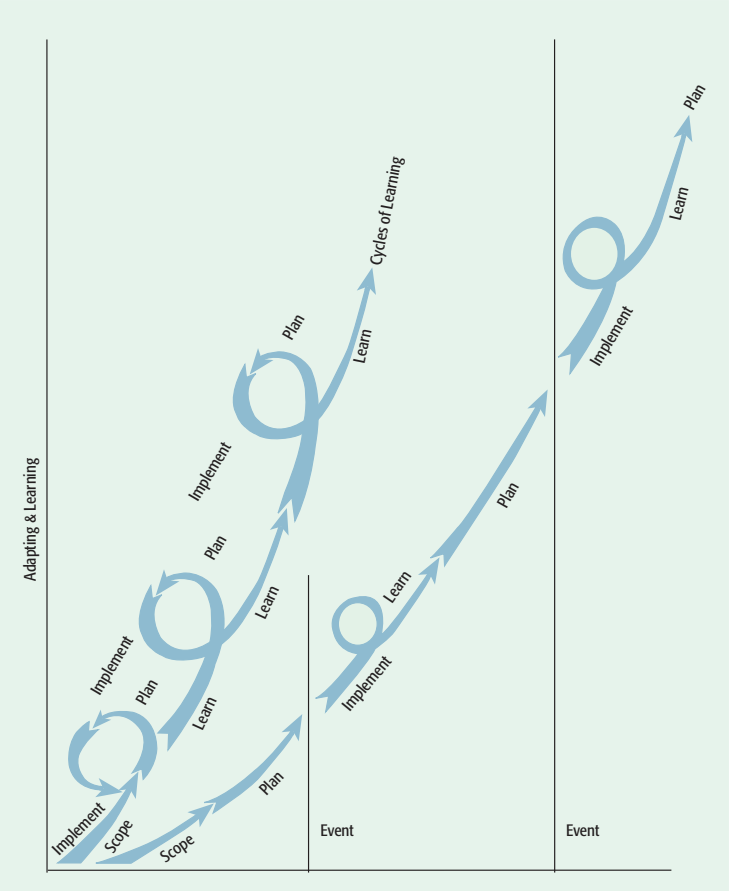
The idea of shared learning dialogues was initially developed as a structural mechanism for both building the views of users into the research process and disseminating research results on an ongoing basis.

As initially conceived, shared learning dialogues were intended to consist of relatively informal roundtable dialogues between the groups involved in research and external governmental, non-governmental and private sector organisations working on related issues. The goal of these meetings was to ensure that cross-fertilisation occurs between researchers and those involved in daily implementation activities as approaches and methodologies are being developed, data are being analysed and results are being prepared for dissemination. By discussing and sharing perspectives at each of these stages, we intended to build awareness (and therefore capacity) within both implementation and research organisations regarding techniques, issues and insights. We also intended to build relationships and create opportunities and incentives for collaboration beyond the core group of organisations involved in the research. This would ensure that the capacities and ideas generated by the programme could be incorporated as core parts of the wider knowledge and implementation environment. This is distinctly different from conventional designs in which results and 'capacity training' are distinct activities 'delivered' to implementation organisations (and which they can take or leave) after the research has been completed.

From the above initial roots, the concept of shared learning is now evolving into a long-term process and set of techniques that can be utilised as a core part of adaptation and disaster risk reduction strategies.

Under this conceptual approach, the perspectives of the implementation organisations and the vulnerable communities they work with would be embedded in the research process through the input they provide at the stage of issue identification and methodology design. At the same time, the back loop from research to implementation will be closed by the same on-going shared learning process between researchers and implementers. Points of commonality would be used to identify 'shared knowledge' and points where commonality is lacking would be used to identify potential locations where specific individual disciplines could contribute specific insights. It is important to recognise that while clustered concepts were seen as indicating large bodies of shared or related knowledge, it was seen as equally important to review instances where concepts are used in unique ways since this could indicate the emergence of new knowledge that falls outside of the standard discourse.

Shared learning process



Conceptual Evolution

From the above initial roots, the concept of shared learning is now evolving into a long-term process and set of techniques that can be utilised as a core part of adaptation and disaster risk reduction strategies. As part of this evolution, issues in making the concept operational – in particular related to the human capacities available – and transforming it from an informal approach to something that can be systematically implemented and replicated are beginning to be addressed. Insights on this from experiences in communicating emerging climate information for the development of adaptation programmes in South Asia are presented below. First, a brief review on the sorts of climate change scenarios that South Asia faces is presented, to give an idea of the sorts of information that we attempted to communicate in shared learning dialogues.

Practical Examples from Cases – Translating Climate Information into Local Contexts

The Climate Change Context

The rivers and other water sources that support agricultural livelihoods in South Asia are sustained by the monsoon and snowmelt from the Himalaya. Vulnerability to climatic change and variability is quite high throughout South Asia. Floods, droughts and extreme storm events regularly impact communities in the region. However, it is through the alteration of water resources cycles that the impacts of increased climate variability and change will be most acutely felt. While there is still much uncertainty about specific regional impacts, broad trends are emerging that indicate that South Asia is already affected by climate change.

Observations and analysis of historical data demonstrate that India's mean temperature has been increasing approximately 0.22°C per decade since 1970. There are more warm nights and warm days throughout the region. While warmer temperatures reduce the risk of frost that could damage crops, many potentially negative consequences, such as a northward spread of malaria and changes to water availability and quality could result from a rise in temperatures. Variability in precipitation patterns increases as the region warms, especially during the monsoon season, simultaneously raising the likelihood of intense precipitation events and greater flooding, while exacerbating drought risk. The IPCC[1] states "There is *very likely* to be an increase in the frequency of intense precipitation events in parts of South Asia…Extreme rainfall and winds associated with tropical cyclones are *likely* to increase in …South Asia."

South Asia is projected to warm about 3.3°C by 2090 (IPCC, 2007), with warming more pronounced in some seasons than in others. Baseflow in many South Asian rivers is sustained by glacier and snowfield melt from the Himalaya. As temperatures begin to rise, the glaciers and snowfields will melt, initially raising baseflows in the rivers. Once these sources of fresh water have melted out, some Himalayan rivers will not be able to meet all the water demands placed upon them. These are only a few of the potential climate change consequences for the South Asian region. Chapter 3 provides a more in-depth analysis of the weather patterns important to South Asia and possible impacts of climate change in the region.

Shared Learning Dialogues

Although the need for "shared learning" was recognised at the outset of the programme as required for the identification of practical responses to climate change, the development of practical methodologies for achieving forms of learning that are truly shared was, and in many ways remains, a work in progress. Conceptual clarity is often

[1] Christensen, J.H. *et al.* (2007), Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Solomon, S. et al. (eds)., Cambridge University Press: New York. pp. 850.

difficult to translate into the messy realities that characterise local contexts. The need for shared learning may be clear – understanding climate change impacts requires combining insights from global scientific research with knowledge only local populations have regarding the specific characteristics of their local region — but developing a practical methodology to meet this need is in itself a process.

Development of the SLD approach outlined here reflects the complexity of this process. All partners involved in the regional research programme contributed to this process.

Conceptual clarity is often difficult to translate into the messy realities that characterise local contexts.

Prior to involvement in the research programme, most partners were familiar with the broad array of essentially extractive techniques used for collecting information from communities as preparation for development activities. The techniques used by partners typically included: surveys, qualitative information collection through sociological / anthropological methods using PRA or RRA methodologies, intensive focus group discussions and stakeholder meetings. Data collected using such tools were analysed using frameworks such as those developed for livelihood and capacity vulnerability analysis. Such approaches are largely analytical and extractive – intended to improve understanding among the actors involved in development as a basis for project or other intervention planning. Although they involve varying levels of consultation with stakeholders, the methods are not, in themselves, generally used as tools for catalysing changes in thought either in the community or the analyst. The reflexive learning goal central to the SLD process was difficult for partners to incorporate in interactions between external themselves and local counterparts.

Development of the SLD process through the project was initiated by orienting local partners to shared-learning concepts followed by group discussion on potential approaches for putting these into practice in our project context. On a practical level, most partners started by organising a series of meetings with village and other communities in case study sites which they then repeated several times. The limitations of this approach became clear very quickly. Because the process for encouraging shared learning remained unclear, meetings felt purposeless and were often organised without a proper agenda. In addition, the need for shared learning to involve diverse sets of actors at different levels, while conceptually recognised, did not match with the "local community / village" focus typical in many development projects. Rather than trying to develop shared understanding across levels ranging from the local community to higher levels in government or the private sector, most meetings tended to focus within local communities. As frustrations began to grow, partners exchanged extensive notes and emails regarding experiences of SLD meetings in different project sites. This intensive exchange based on initial experiences with SLDs was essential for clarifying both the techniques and larger objectives that are now central to the SLD methodology.

The intensive exchange of insights from different attempts to implement SLD concepts generated a variety of practical applied approaches that are now central to the SLD methodology. *First*, it was recognised that shared learning can't be

thought of in the extractive information collection mode common in many stakeholder consultations – it requires a real exchange of information and insights. As a result, preparation (bringing new information in) is essential and needs to be combined with a willingness and ability to "listen" to counterparts. This is the essence of the two-way process. Furthermore, the process needs to be iterative. This doesn't mean just "more meetings" (discussing exactly the same thing twice is rarely productive). Instead it means sequential meetings – the holding of meetings on a regular basis but only when they can either add to understanding by clarifying the perspectives / knowledge of different groups, or are required because new information is available.

Second, the importance of including multiple groups in the SLD process became clear. Because the impacts of climate change cut across scales and because responses require action across groups working at very different levels, shared learning won't be effective and can't translate into action if it only involves local communities. As a result, the importance of repeating the SLD exercise with diverse groups in communities, the government, private sector and NGOs as well as across scales (local, state, nation, etc...) was gradually recognised. More meetings are often required at the local level in order to articulate issues and concepts to groups that are less familiar with global issues – but some level of iteration is required at all levels.

Third, shared learning will ultimately need to be linked to action. As illustrated in the accompanying diagram, shared learning involves a cycle in which initial dialogue forms the basis for implementation decisions, implementation provides new experiences and new experiences are the basis for new learning. This can either be a clear sequential process – or one that is driven by episodic events (such as floods) that draw attention to an issue.

SLD experiences gained indicated that to be effective:

1. SLDs need to involve a diverse array of social groups;
2. SLDs involve iteration – but this requires continuous introduction of new information or perspectives, not just reiteration of the same discussion;
3. More meetings are often required at local levels than at higher levels – but discussions at all levels are central to shared learning.

The Nepal case illustrates the variety of issues that can emerge from the SLD process.

The Nepal Case

In Nepal SLD was conceived as a process of reflexive learning in which one set of stakeholders could learn from others' perspectives on flood disasters and use that information to identify strategies to reduce disaster related risks. The approach was intended to introduce insights from the social and natural sciences into established theories of vulnerability and risk assessment. The underlying assumption was that while technical experts know a great deal about how natural systems work and interact, villagers are directly affected by floods and droughts and, as a result, are most aware of the social and environmental contexts that they deal with every day.

We began by creating a broad framework outlining the various steps of

It may not be possible to conduct a formal – one-day – district or state level SLDs all the time.

the process. Preliminary meetings were followed by a series of in-depth interactions with communities, representatives of community groups and government officials. The process as a whole was used to formulate an interactive method for carrying out local-level assessments of the natural hazards in selected VDCs, how vulnerable the VDCs residents were, and for coming up with disaster risk mitigation strategies.

A total of eight SLDs were held: two national-level ones in Kathmandu and six local level ones at the case study sites. Representatives from government and non-government organisations (NGOs), media persons and representatives of partner organisations from India participated in the national-level SLD.

The objectives of the national-level SLD were as follows:

- Discuss how the participating organisations approach disaster risk reduction through a sharing of experiences; and
- Initiate discussions of possible approaches to disaster risk mitigation and long-term development, and of options for interventions.

For local-level SLDs the objectives were as follows:

- Share the entire community's knowledge about managing flood disasters, including their response mechanisms , attitudes and behaviours,
- Assess how various affected people adapt to flood impacts and how they perceive disaster risks,
- Prepare local-level hazard maps, and
- Develop and finalise a vulnerability-assessment tool.

In order to assess vulnerability, we reviewed relevant literature, reports and other documents and asked local partner NGOs and other key informants regarding their perspectives. We used the insights we gained to identify a set of parameters, which we then discussed with experts to assess their relevance. Trying to include all the impacts that a flood-affected person is likely to face, we finally developed a check-list of twenty-five parameters, each of which was to be assigned a rank ranging 1 for limited vulnerability to 5 for severe vulnerability. At the six village-level SLDs, participants discussed and critiqued the parameters and suggested modifications. Then, in a simulation exercise, each participant filled in the checklist. The lessons which emerged were used to refine the checklist a final time. The final checklist was used to assess the extent of vulnerability in each of the four VDCs after hazard maps for each were prepared. The key outcomes are analysed in greater detail in Chapter 6.

To summarise, key constraints identified in the Nepal case are as follows:

- Selecting a suitable place to hold an SLD was difficult. In many towns of the Tarai, there is no suitable meeting hall and if there is one, making arrangements to feed the participants is difficult. In addition the sanitation and general environmental conditions of such facilities was frequently poor.
- Another difficulty lay in the long commute participants faced. While the participants from the village of Bramhapuri travelled the 10 kilometers to Gaur, the city where the meeting was held, by horsecart, the participants from Bhasedwa had to travel 25 kilometers. The longer distance meant more time had to be

spent and made for more logistical difficulties.
- The poor condition of the road rendered the trip uncomfortable.
- Women participants preferred not to spend a night in a local lodge. They wanted to return to their homes. Since they had to reach home before sunset, the sessions had to be terminated earlier than planned. The problem of assembling participants in a common meeting hall or site could easily have been avoided by holding the SLDs in respective villages, but only if there had been sufficient resources and manpower. In any case, some degree of commuting was inevitable because interaction among residents from different villages also had to be held.
- There was often insufficient time allocated – and available for the discussions.
- Communicating with participants was a challenge. While many could understand Nepali, they could not speak it well. The low average level of educational achievement was another factor complicating discussions. This limitation was addressed by involving research associates skilled in speaking the local language.

On the basis of the SLDs we conducted, we drew the following general lessons:
- SLDs are useful mechanisms to facilitate the exchange of information among researchers and local people.
- Field staff must work as a team by taking an egalitarian approach to dialogue.
- Field teams need to understand the issues of climate change and disaster risk reduction. Key ideas about these issues should be made available in a language locally understood prior to holding SLDs.
- Ideas put forth by community members must be respected. Recognising that impractical ideas will naturally get filtered out as they progressed with the SLDs, facilitators must still list out the ideas they disagree with.
- Context-specific local knowledge will enrich expert knowledge and vice-versa. While local communities often consider expert knowledge to be more valid than their own, SLDs should serve as an opportunity to challenge this misconception.
- The notions of vulnerability that local participants bring to discussions consists of a number of stories. While these may appear incoherent, they have important institutional, cultural, and social implications for reducing vulnerability.
- SLD is a useful method for getting the members of a flood-affected community to begin considering the nature of local hazards and the sources of vulnerability.
- Techniques such as social mapping are more useful when they are used in conjunction with existing topographic maps. The communities develop a much better appreciation of the character of a hazard by using such maps.
- Members of a community are ordinarily enthusiastic about using participatory tools and about making presentations regarding their experiences and develop a strong sense of ownership of their problems and the solutions they identify.
- The processes of SLDs need to be thoroughly documented. Every point community members make and every step taken must be recorded.

Key constraints identified were: difficulties in arranging meeting places; difficulties participants had in travelling; time constraints; and issues of communication between the different actors.

The Uttar Pradesh Case

In Uttar Pradesh the case areas selected for evaluation are, as described in more detail elsewhere in this publication, near Gorakhpur. Since India's independence, disaster risk reduction interventions in the area by the government have emphasised structural control. Large amounts have been invested, primarily in embankments. These, along with the expansion of roads and railways have altered natural drainage patterns substantially. As a result, the flood disaster context is heavily affected by the larger process of development and the history of flood management attempts. This is also the case with drought where expansion of well irrigation coupled with changing agricultural practices has substantially altered vulnerability to droughts. Overall, unlike the Nepal case, the history of structural control and other responses represents an important part of the context in which SLDs were being conducted. Our focus in conducting the SLDs was to identify alternative strategies for risk management that could be contrasted with these existing control-based strategies. Alternative approaches to flood and drought management are being explored, mostly by NGOs. These approaches are part of the dialogue on disaster risk reduction in the region – but have often not been translated into specific actual actions that can be implemented.

The flood disaster context is affected by the larger process of development and the history of flood management attempts.

As with other partners on the project, we began conducting SLDs with a view to collecting data, information, and community perceptions on disasters and vulnerability from the project villages. Information from a previous study conducted in these villages was used to understand characteristics of the

area. The SLDs were initiated with a standard set of conventional focus group discussions in the project villages. In each village, SLDs were held in which community members as well as *panchayat* members participated. They identified and discussed the issues and problems in the village.

The SLDs were supplemented with scoring and ranking methods to identify (and prioritise) the most severe problems, giving preference to problems faced by the community at large over problems faced by individual households. In-depth discussions were held on the problems. Causes and effects of risks were analysed using social maps developed in a participatory manner with the community. The SLDs resulted in identification of a package of interventions that are different from the large structural measures that have dominated past flood control efforts and can be implemented at the village level. These measures are currently being evaluated as part of our larger study of the costs and benefits of disaster risk reduction study.

The Pakistan Case

Research in the Lei Basin in Rawlpindi was originally planned to be implemented through a series of shared learning dialogues. Although clearly conceptualised, key elements necessary to change broad concepts regarding the importance of shared learning into a practical methodology had not been tested in the field. In consequence, we confronted considerable difficulty in implementing it as a methodology. The process we ultimately went through to achieve this illustrates both the power and challenges inherent in such processes.

For undertaking the SLDs and other elements of the research, our local partner organisationsation, PIEDAR, took the lead field role. PIEDAR was responsible for hiring a field team for research purposes and because of other on-going work in the research area, had an established field office in Rawalpindi. PIEDAR recruited a team of one team leader and two research assistants specifically for this research. Training workshops and detailed discussions were held with the field study teams to sensitise them to the ethos and techniques involved in conducting SLDs. Some of the salient points stressed to the field teams included the following:

- SLDs are meant for exchange of information rather than extracting it.
- In order to encourage sharing across all communities, the field team must have a non-hierarchical structure and open channels for articulating dissent, and clarification of information.
- Field teams must not passively depend upon the more specialised topical specialists of King's, ISET or PIEDAR to hand down information or methodology guidelines. Instead the field teams should be active learners engaged in constant communication with the topical specialists, in addition to reading and researching the issues of concern for the SLDs.
- Communities and the institution based research subjects must be approached in a spirit of mutual respect in a spirit of truly shared learning as well as extracting information.
- Contextual local knowledge can be enriched with expert knowledge and

Although clearly conceptualized, key elements necessary to change such concepts regarding the importance of shared learning into a practical SLD methodology at the field level had not been tested.

vice-versa. Neither type of knowledge should be given dominant attention and respect. The goal of SLDs is, in fact, directed towards achieving precisely that balance.

- The interaction between local and expert knowledge could and should yield actionable suggestions, in our case, for mitigating vulnerability, identifying institutional, cultural, and social points of leverage for policy interventions and for clarifying the social and perhaps even economic benefits and costs of different courses of action.
- The implementation of SLDs must be thoroughly documented and the temptation to filter information or various steps in conducting fieldwork must be resisted.

Limitations on the ability to successfully conduct SLDs appeared to arise primarily from the nature of the field teams.

The dialogue in each site was conducted in gender-segregated groups. Although it may have been possible to have the dialogue in a mixed group, previous experience shows that women do not speak up in large gatherings, especially in the presence of male participants. Their inputs and discussions in the same-sex groups are much richer and unrestricted. Therefore, a team of two researchers carried out the dialogues with one conducting the proceedings and the other recording them. Audio-visual aids were also used to make recordings as the communities in question allowed their use. This allowed for better documentation and the possibility of data mining in the future.

Unfortunately, despite the training, in many cases the team was unable to move beyond a classic focus group discussion with the field team interacting with the research subjects in an extractive mode rather than an information-sharing mode. The field reports were also lacking in the type of richness and nuance that was expected from SLDs. Therefore, instead of the SLDs being the bedrock of research and analysis at the community level, other methods, such as secondary data analysis and the group meetings ended up being the main conduits for vulnerability analysis.

Limitations on the ability to successfully conduct SLDs appeared to arise primarily from the nature of the field teams. Although the teams had substantial field experience (or perhaps precisely because of this experience), they had substantial difficulty moving out of more project directed top-down forms of interaction with local communities. In addition, although the field teams had substantial training in the objectives of the SLDs, they did not have substantial experience with climate related issues. As a result, they may have been limited with respect to the number of new ideas / perspectives they were able to bring to the dialogue. Overall, success and failure, like most things in life, appeared to depend heavily on the nature and training of the people implementing the process. Perhaps it is important that more highly trained people than the field team members implement the methodology. In fact, it's possible the field team model is not suitable for implementing SLDs–the process cannot be delegated down by researchers. Instead, researchers with a view of the research problem and its context ought to be doing it themselves.

Despite the above limitations, the SLDs conducted in the Lei have had major

benefits. They resulted in a two-way dialogue where the research team, after recording the views of the respondents, also shared results from previous research and technical details on various issues like costs of various risk reduction options, climate change forecasts and consequences of the river realignment, etc. They also provided, in some cases, the opportunity of sharing viewpoints across a range of actors - an exchange that does not take place in normal circumstances.

Overall, the SLD process was instrumental in getting a wider perspective on the flood hazard in the Lai floodplain. It was also a good tool to disseminate technical knowledge on disaster creation among various actors. There seemed to be a considerable level of appreciation for such thinking in some quarters and, in others, the organisational objectives had to be protected.

Only one round of SLDs has been done so far. The ultimate value of the approach needs to be assessed after a couple of rounds.

The Tamilnadu Case

Unlike the Pakistan case where SLDs were conducted by a local NGO, SLDs in Tamilnadu were organised and conducted by a research-focused organisation, Madras Institute of Development Studies (MIDS). The shared learning dialogues were conducted at three levels (within villages in different coastal ecosystems, at the district level and at the state level), with specialist groups (primarily research institutes, civil society organisations, government organisations and the private sector). The methodological structure followed in the Tamilnadu case is outlined in a diagram contained in the accompanying Tamilnadu case study (Chapter 9). All the shared learning dialogues involved intensive discussion regarding the impacts of climate change on coastal regions and the potential response strategies. The dialogues resulted in a relatively clear breakdown regarding points where perceptions regarding the implications of climate change and potential response strategies converge between different groups and where they diverge.

Village level SLD

Following an initial scoping process involving background information collection and a series of relatively unstructured SLDs, the SLD process targeted at the village level was refined and carefully structured. The steps in this process were as follows:

- Found various boundary partners in the region
- Developed relationship with NGO Coordination and Resource Center and with few other NGOs in the region
- Collected from NGOs baseline information on the region and a potential list of villages where we could start our work
- Selected villages after prolonged consultations
- Identified various social groups such as: fisher community, small and marginal farmers, Scheduled Caste farmers and landless agricultural labourers, shrimp farmers, SHG members, women labourers, village leaders / village institutions etc. Care was taken to include both groups that are generally perceived as being vulnerable to climate impacts and those that are thought to be less vulnerable.
- After identification, SLDs were planned and carried out with each one of the identified groups. Before

SLDs in Tamilnadu dialogues resulted in a relatively clear breakdown regarding points where perceptions regarding the implications of climate change and potential response strategies converge between different groups and where they diverge.

conducting a SLD, our technique was to visit the village on the previous day and identify the potential participants and prepare them for the SLD on the next day. Usually, each SLD takes about 4 to 5 hours. At the end of it, we identify potential participants from the next social group and prepare them for the SLD to be conducted the next day. The number of participants in each SLD varies from 6 to 20 and participants are both men and women.

- After documenting and synthesising a series of SLDs, MIDS organised a district level SLD. The results of all these were then taken to the state level SLD.
- After a gap of a few weeks, local level SLDs were repeated with more questions and with refinement.

District level SLD

A district level SLD was organised with a view of flagging the insights gathered from village SLDs for further dialogue with district level officers, agencies and community leaders. Organising a district level SLD took considerable time – for organising logistics, identification of potential participants and so on. Key participants at the district level SLD include the district disaster management officer, the District Collector, officials from the fire service, the forest department, insurance companies, an officer from NABARD, researchers, an agricultural research center soil scientist, the Director of NGO Coordination and Resource Center at Nagappatinam, several NGOs, a local cable TV operator, mobile operators, farmer and fishermen leaders, and women from SHGs. This was a day's workshop, which was attended by 40 participants.

State level SLD

The key learning and emerging issues from the SLDs conducted at the village and district levels were taken to a state level SLD workshop. The state level SLD (which was a day's workshop) was attended by state level officers such as the Relief Commissioner, the Revenue Secretary, officials from the meteorology department, officers from insurance and banks, NGOs, state-level and district level fishermen and farmers' leaders, researchers among others.

Insights Emerging from the Local, District and State Level SLDs

SLDs conducted at the village, district and state levels indicated strong points of convergence with respect to the implications climate change has for coastal regions. Perspectives on potential courses of action, however, converged in some points and diverged in others.

Where impacts of climate change are concerned, perspectives on the threat to coastal regions emerging from the IPCC and other sources largely converged.

Where impacts of climate change are concerned, perspectives on the threat to coastal regions emerging from the IPCC and other sources largely converged. Villagers already believe they are losing land to changes in sea-level – as the case study documents, they could clearly indicate regions where the ocean margin has submerged large tracts of land during recent memory. Much of the coastal region is already below sea-level and virtually all of it is within 5 meters of it. Salinity increases due to encroachment of sea water on coastal lands and aquifers are also widely recognised as likely to be exacerbated by climate change. The impact of cyclones on coastal areas was in the forefront of the mind of most local actors as well – along with the implications of any increase in cyclonic frequency or intensity. From the local perspective, agricultural yields and production have

already decreased by at least 50% due to natural disasters such as cyclones, sea water and fresh water floods, land and groundwater salinity.

Where response strategies were concerned, approaches that emerged regularly at all levels in the SLD process included:

1. *Structural control measures:* In most dialogues there was an initial emphasis on the need for structural measures (regulators, drainage channels and river embankments) to control flows and limit the ingress of saline water.
2. *Financial mechanisms:* Improvements in credit and insurance to reduce reliance on informal systems, reduce losses due to climate related events and enable the development of new economic activities were widely identified as essential in order to reduce the impacts of climate change.
3. *Drinking water supply:* Improvements in drinking water supply to coastal areas to enable populations to remain as salinity increases.
4. *Weather information and early warning:* Improvements in weather information and early warning systems were frequently identified as a key need in response to projected changes in weather patterns. Weather information is currently viewed as grossly inaccurate. Only very obvious warnings at very obvious times are issued, whereas accurate predictions well in advance were sought. Currently the fishing population depends upon local knowledge for 90% of their weather forecast needs.
5. *Shifting occupations:* Improving the ability of local populations to shift occupations through education and skill acquisition in non-fishing and non-farm activites was widely identified as essential to respond to the impacts of climate change on coastal areas.
6. *Crop shifting:* Within agriculture, shifting to salt resistant crops, in particular traditional varieties of paddy.
7. *Development of infrastructure that is adapted to projected changes:* There was substantial debate regarding the type of houses that should be constructed for people who live close to the sea. Reinforced concrete construction does not survive long because the steel gets corroded very quickly. Many suggested tiled houses to cope with the corrosion problem, but a few also argued that, from the point of view of coping with cyclones and high speed winds, concrete houses are far better.
8. *Improving administrative capacities to respond to extreme events.* Floods, cyclones, etc. happen every year but the administrative capacity to handle these disasters is often viewed as inadequate and unsustainable.
9. *Improved environmental management:* In particular managing mangrove and dune ecosystems for coastal protection and controlling pollution to improve the productivity of brackish water areas emerged as a regular priority in the SLDs.

Many of the above strategies would probably be recognised as important across the spectrum of actors from the global scientific community to local villages. Others, however, represent points of divergence in perspectives. From a technical perspective, for example, the construction of river

Many of the strategies identified through SLDs would probably be recognised as important across the spectrum of actors from the global scientific community to local villages. Others, however, represent points of divergence in perspectives.

regulators in large deltaic areas could only provide an interim level of protection if sea-levels rise substantially. As a result, this type of approach represents a space where perspectives diverge and the development of further understanding would be required to determine whether or not it could contribute to adaptation.

In many cases, core elements of meaning are difficult to translate across scales.

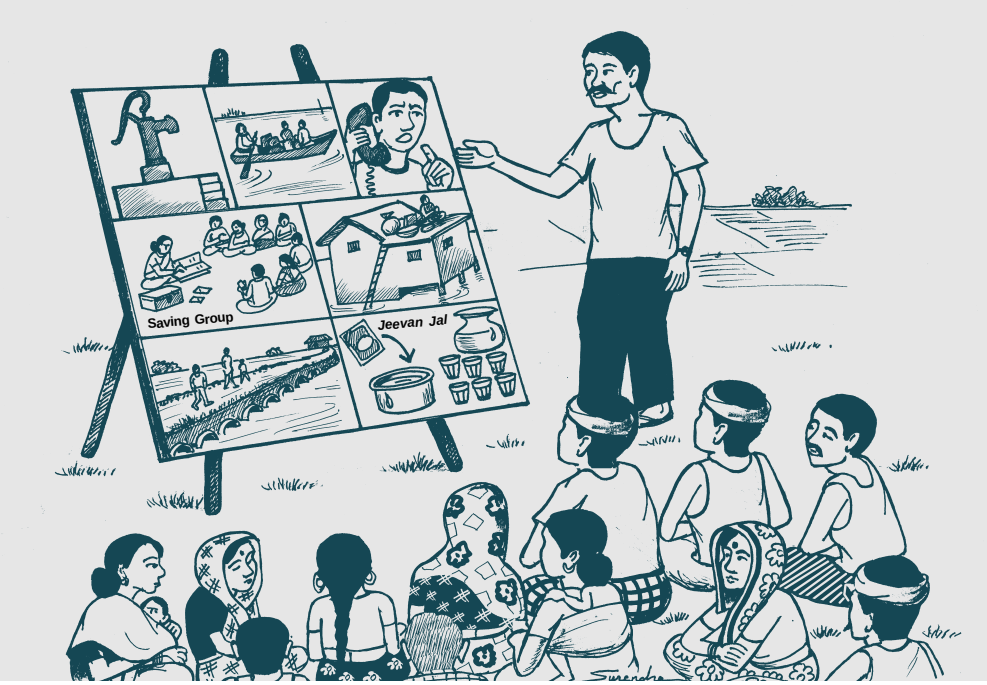
Where the practical logistics of the SLDs were concerned, success depended heavily on organisation. The programme for the district level SLD needs to be carefully designed in such a way that key emerging issues from the village level SLDs are presented one by one so that dialogue is generated. Village level SLDs take time – people often bring out standard approaches that they have experience with or have seen in other areas. It takes time and work to get them to think beyond these approaches. Finally, for the meetings to build off each other, it is important to have a clear record of what was said.

To achieve this it is necessary to have a good audio-recording system to record the day's proceedings.

Key Issues in the Current SLD Process from Tamilnadu

Some of the key insights from the SLDs include:

- *Perceptions of hazards and risks vary greatly between groups.* Though overall, at the village level, droughts and floods are perceived to be a form common of disaster, the village level definition of 'hazards' often did not tally with the official or other definition used. For example, villagers define drought as those periods when their crops require water but there are no rains. This definition is different from that used by the state government which is based on deficit in total magnitude of annual rainfall as compared to normal value. Similarly, where the



external (expert) concern was over storm impacts, villagers perceive that waterlogging is a critical 'hazard'. Finally, frequent but low impact events were seen as a critical set of hazards versus low frequency disasters with high impacts. In relation to this, four important questions emerged which stakeholders felt are important to consider while designing DRR strategies:

- How do we sustain proposed adaptive strategies for DRR (insurance, communication mechanisms, early warning systems) for low frequency but high impact disasters?
- Should the focus be on high frequency but low impact disaster events while developing adaptive strategies, albeit keeping high impacts events in mind?
- How do we integrate overall development with adaptive strategies?
- How do we address the fact that market and larger political dynamics can exacerbate the vulnerability of local communities?

- *A variety of local practices exist to reduce risk.* These take the form of diverse activities villagers are implementing on their own in response to the hazards they face. Such activities include: (1) Storing of seeds: Traditionally people store seeds that were bartered after a disaster. Currently only small farmers preserve seeds while richer and large farmers purchase them from the market. This practice of storing seeds has been a recent phenomenon; and (2) Migration: Seasonal migration helps local communities that are regularly affected by floods to cope with the losses that they incur due to these events.

- *Improvements are needed in a variety of disaster control measures.* Examples included issues with early warning systems and crops. Where early warning systems are concerned, there was a widely articulated need for them to devolve below the region, district or block level to the village level. People of Lakshmipur village suggested that if they could receive information on water levels then preventive measures could be taken to save their asses, including crops (in one flood event at least). At present people get some information on the probability of flood events through newspapers and radio. Such information is not considered specific enough for them to gauge if their village is likely to be affected or not. Currently, the villagers self-monitor water levels in the river flowing next to their village. They use this observation to assess if a flood is likely. Where alternative crops are concerned, farmers were interested in knowing about suitable alternative crops that they could cultivate so as to minimise crop damage due to flood (or poor rainfall) events. These could include early-sowing, short duration crops that can be harvested before the onset of the flood prone season (July-August), including those that can survive in waterlogged conditions.

Where the research process was concerned, the SLD process proved quite effective. The SLDs, for example, helped gather perceptions on costs and benefits of DRR strategies / measures. Embankments as a preventive measure

SLDs at the state level proved to be an effective tool for expanding the dialogue to cover policy issues in addition to field-based issues.

Repetition is generally essential in order to observe evolution in the way local counterparts view and incorporate climate or hazard information in their own perspectives.

against floods were characterised as both a boon and a bane. The case of Lakshmipur illustrates this well. Lakshmipur village (eastern UP) has a ring bund constructed 35 years ago. The bund almost surrounds the village. In 2001, the embankment protected the village from floods. But subsequently the embankment breached washing away part of the village. This breach also led to the formation of a pond on arable lands. The ring bund also blocks the drainage of rains that fall within the area resulting in waterlogging. Though soil is fertile, agricultural productivity of the area is affected. The Irrigation Department is responsible for the maintenance of the bund, but it is poorly maintained. As a result there is a threat of it breaching and inundating the village. The SLDs at the state level also proved effective. They enabled expansion of the dialogue to cover policy issues in addition to discussing field based issues. They enabled discussion of the needs of communities and the policy changes (if any) required to meet such needs. Put simply the SLD helped discuss the issue of 'how best to translate policy into action.'

The above said, care was needed in managing the SLD process to make it effective. Without careful management, the discussion often shifted immediately into questions such as: 'Who should undertake activities?' and 'What needs to be done?' This was often premature – before any real shared understanding of the problems and alternatives for addressing them had evolved. In addition, the various government department representatives were often defensive at first. Once they understood the objectives and processes better, however, they tended to give achievable incremental 'way ahead options' for disaster interventions through SLDs. Overall, the Tamilnadu experience indicates that:

- SLDs conducted with disaster affected communities at the field level can serve both as a platform for sharing experience and also help identify useful solutions for problems.
- SLDs can act as a triangulation and validation tool for data and information collected from other sources;
- SLDs are useful in capacity building of community members and of the project team.
- SLDs can be useful as a two-way knowledge transfer process. It can enable communication of technical information and details of global warming to local communities. At the same time, it enables communities to explain the impacts at the field level (both existing and expected) in terms of occupational mobility, migration patterns, livelihood systems, etc.
- SLDs can be used to create a continuous engagement with stakeholders that goes beyond giving feedback or sharing project experiences and findings. The process becomes inclusive and integrative as stakeholders at different levels understand that this is not a one-off exercise.

Summary of Experiences and Ways Forward

While the need for reflexive learning processes is clear in both the disaster risk reduction and climate adaptation cases, the initial attempts to develop and implement this type of process have raised a series of key issues, many of which are central to most strategies for participatory development. These issues include:

1. *Deeply embedded attitudes on the part of development experts (including ourselves) regarding the process and objectives of research and implementation programmes.* Analysts tend to either focus on 'bottom-up' approaches that emphasise community perspectives and processes or on 'top-down' approaches that emphasise the role of high-level actors. Reflexive learning across these scales requires an uncomfortable balancing act.

2. *Capacities of available staff.* In the Pakistan case outlined above it was extremely difficult to capture perspectives or knowledge expressed in meetings at different levels because of the embedded perspectives available staff brought to the process. In addition, the staff had in many ways as much difficulty understanding the implications of climate change or hazards as local communities. *Who* is guiding the dialogue process and the *attitudes, willingness to learn* and *technical familiarity* with the issues involved is of critical importance. Many socially focused development processes have downplayed the role of technical knowledge. Understanding risk and the implications of climate change does, however, require basic familiarity with technical concepts.

3. *Mechanisms for harvesting lessons*: Systematic processes need to be developed for harvesting the exchange of knowledge and documenting the evolution of perspectives on strategies for responding to hazards and climate change across scales. Major challenges exist in ensuring actors at different levels do not filter out or ignore insights from other levels. The contents of field notes from SLD meetings were, for example, often not reflected in the write-ups produced by actors charged with guiding the process. Recording, transcription and qualitative analysis of the dialogues is being done – but this is time consuming and may not be replicable in many programme contexts.

4. *Managing the chain of learning across scales*: The capacity and mechanisms issues discussed above greatly complicate the management of learning across scales. The reflexive learning objective central to the SLD process needs to be clearly understood along the full chain of actors involved in research and the development of programmes from the very local level up to state or national policy actors. In many cases, core elements of meaning are difficult to translate across scales. As a result,

the ability of facilitators to work at multiple scales may be of central importance for such processes to work.

5. *Accessibility of the process for key groups*: As with many social dialogue or stakeholder processes, access can be affected by gender, class or other considerations. Identifying the sets of boundary partners or groups it is important to work with and ensuring accessibility of the process is a critical issue.

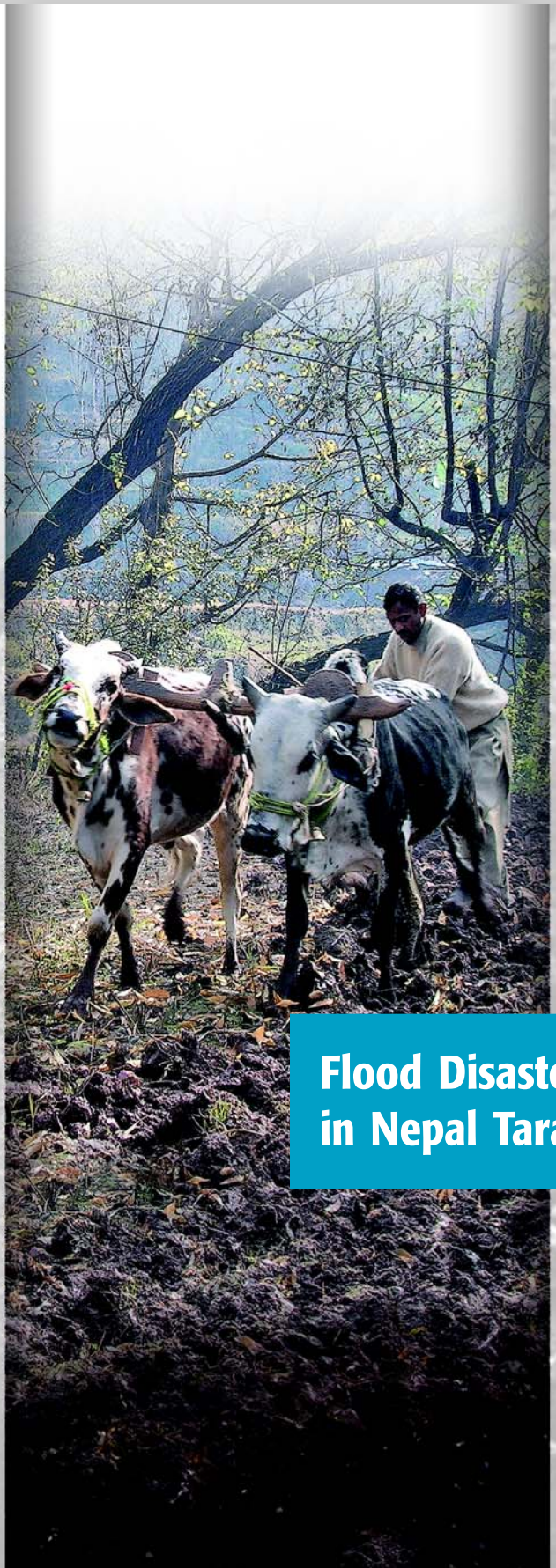
6. *Objectives of the process:* Researchers involved in SLD processes often view them as mechanisms for data collection on capacities and vulnerabilities, livelihoods or other community characteristics rather than understanding the reflexive learning objective. While information on such characteristics can and does arise out of the SLD processes, lack of clarity on objectives can be a key constraint. This is also the case with local counterparts involved in such dialogues. Initial dialogues are often viewed only as part of project planning or research. Repetition is generally essential in order to observe evolution in the way local counterparts view and incorporate climate or hazard information in their own perspectives.

To move beyond existing experiences with SLDs and create an effective process for reflexive learning in response to hazards and climate change the sets of activities would need to be structured and made much more systematic.

The above types of issues are probably inherent in any process intended to encourage learning and the development of new knowledge across disciplines and scales. To move beyond existing experiences with SLDs and create an effective process for reflexive learning in response to hazards and climate change the sets of activities would need to be structured and made much more systematic. As envisioned here, an overall process of this type would have five core steps:

1. Scoping to identify key actors and features in regional contexts that determine hazards and patterns of vulnerability.
2. Building common understanding to identify potential interventions to reduce risk and respond to climate change;
3. Structured review of potential interventions through a strategic mapping process that evaluates proposed interventions to avenues for either directly reducing risk and supporting adaptation or to strengthening the underlying systems that enable populations to respond to risk and change processes as conditions evolve;
4. Financial analysis of costs and benefits of interventions including sensitivity to key uncertainties; and
5. Implementation

Shared learning dialogue processes would dominate the second of the above steps but are present at each phase and should, ideally, provide a basis for cycling back from implementation to another round where learning replaces scoping but the process otherwise remains identical. The structured review step is the critical element required to translate the array of potential interventions identified through shared learning into courses of action that can actually be implemented. The core activity in the structured review step would be to map potential interventions onto a matrix that relates them to the factors known to support risk reduction and adaptation either directly or at the level of underlying systems.



6

CHAPTER

Flood Disaster Impacts and Responses in Nepal Tarai's Marginalised Basins

Ajaya Dixit, Madhukar Upadhya,
Anil Pokhrel, Kanchan Mani Dixit,
Deeb Raj Rai and Madhav Devkota

Case Study Guidance Note

Country: Nepal
Location: Nawalparasi and Rautahat Districts. The coordinates of four study sties are:
a. Brahmapuri N 26° 44' E 85° 19' **b.** Bhasedwa N 27° 02' E 85° 14'
c. Rampur Khadauna N 27° 26' E 85° 43' **d.** Devgaun N 27° 29' E 83° 42'
Date: May 2007
Sector and Spatial focus: Flood related disasters and Northern Gangetic plains
Title: Flood Disaster Impact and Responses in Nepal Tarai's Marginalised Basins
Bibliographical reference: Dixit A. *et al.* (2007) *Flood Disaster Impact and Responses in Nepal Tarai's Marginalised Basins*

Abstract

The Gangetic plain is home to some of the poorest populations in the world. Their impoverished living conditions are often attributed to regular floods and drought-like conditions. Flash floods, inundation for prolonged periods, bank-cutting and sand-casting devastate life, livelihoods and property for the already poor, especially within marginalized (smaller, un-gauged) river basins. Each disaster makes the poor more vulnerable to the next and, consequently, each single disaster is converted into a process. The problem of flooding is exacerbated by built systems including flood control embankments and urbanisation which constrict natural drainage patterns. In addition, communities report increasing rainfall intensities and changes in the timing of precipitation, especially in the last few decades. This also exacerbates flooding.

This paper presents preliminary findings of a programme in the Nepal Tarai on disaster risk reduction (DRR) and adaptation to climate change. The study includes pilot testing of some strategies identified in four sites within the Bagmati and the Rohini river basins. Adaptive strategies for four communities in these two river basins have been identified using a number of tools. These are segregated as adaptation specific interventions and underlying systems for adaptation.

Technical Description

- Hazard / risk type: Flooding
- Type of assessment: Research to understand the factors that constrain and enable local communities to reduce risk and adapt to climatic and other sources of vulnerability.

Contextual Notes

- Frequent shifting of rivers has permanently displaced homes in Bhasedwa and Brahmapuri village development communities (VDCs) of Rautahat District over the last two decades. In Devgaun and Rampur Khadauna VDCs of Nawalparasi District, most displacement is temporary. Families take shelter at their relatives or in public buildings such as schools during periods of high floods.
- Prior recovery attempts in all four VDCs were primarily limited to distributing petty relief materials such as food and blankets. In some VDCs, organisations such as the Nepal Red Cross

Society, Oxfam GB and local NGOs have initiated group formation, distribution of information kits, installation of communication equipment, wooden boats and construction of small shelters.

- Construction of physical infrastructure such as canals, roads, railways and efforts in 'taming' rivers has had negative consequences. Structures, built along the Indian border, have in many instances been related to the cause of flooding. During flood periods people commute long distances in search of daily labour.
- The eastern Tarai political unrest has intensified despite a peace accord to end a decade-long insurgency. Protests (mostly violent) and unexpected and continuous strikes have affected accessibility to the communities and delayed visits to communities since January 2007. In the third week of March 2007, about 30 people were beaten to death in Gaur, the district headquarters of Rautahat. Brahmapuri, one of our study sites, is situated 5 kilometers east of Gaur.

Research and Analytical Process

- Methods / tools used: Scoping, Shared Learning Dialogues, Household Surveys, Mass meetings, Capacities and Vulnerability Analysis, Ranking, etc.
- Role of Climate Information: Climate information is non-existent. People hear weather information on radio and television programmes.

Key Insights Generated for Vulnerability Reduction and Capacity Enhancement

- In all four project sites, poor access to information and gender issues emerged as major factors contributing to vulnerability. Information refers to policies, news, radio, knowledge about relief activities, information on floods / rainfall and knowledge of selling price for local produce in nearby towns.
- Women, particularly pregnant women, lactating mothers, women who have recently given birth, elderly women, the disabled and menstruating women are more vulnerable.
- Spontaneous measures of adaptation (such as building flat-roof houses, two-story houses and houses on raised plinths) have been widely observed. Livelihood elements that are not likely to be much affected by inundation or flooding are also increasingly pursued. Examples include an increasing preference for water buffaloes over cows and ducks over goats. In addition, young men migrate in search of alternative livelihoods.
- Adaptive strategies can be categorised into climate adaptive interventions and underlying systems of adaptation. Tables A and B present the findings.

Potential Strategies Identified

See tables at the end of this guidance note.

Strategic Notes and Lessons Learned - Key Points to Emphasise

The study has provided three main lessons. First, in the last 50 years there has been reliance on the structural or macro or engineering approach to mitigate flood damage. The concerns of affected individuals, families and communities have not been systematically woven into decision- and policy making. Government policies have not contributed to building resilience for coping with floods. Second, cooperative efforts of the governments of the region have been technologically guided in a project-centric mode. Despite repeated references to flooding and the need for its mitigation in pubic discussions, cooperative efforts have not aimed at building institutions for mitigation. Third, institutional dysfunction is widespread as state agencies fail to innovate in effective responses to flood disasters.

TABLE A | Adaptation Matrix for Nepal VDCs: Adaptation Specific Interventions

VDC	Diversification	Ecosystem	Disaster Risk Reduction	Organisation and Incubation	Skill Development	Financial and Risk Spreading	Communication
Rampur Khadauna	Farming on land affected by sand casting (e.g. guava, watermelon). Productivity enhancement. Access to forest resources, diversification of income (floriculture, nurseries, etc.)	Community forest plantation	Seed bin storage, improved homes and shelter (e.g. hooks on existing flat roofs to tie tents), boats, raised roads, first aid kits, raised tubewells; *panyalo* (RWH), chlorination, hanging seed beds, improved cooking stove, spurs construction with bamboo sticks and sand-filled bags, seed banks	Self-help groups, saving and credit, community groups, train local youths to become volunteers at times of disaster	Non-formal education, community health and sanitation awareness trainings, exchange visits, gender sensitisation, accounting and leadership training, promoting biogas and briquette	Crop and cattle insurance, life insurance, savings and credit group formation by cooperatives theme	Early-warning system, rain gauges, networking through volunteer organisations, land line and mobile phones, CDMA, community FM, radio programmes, TV and press
Devgaun	Farming on land affected by sand deposition (e.g. banana, guava, watermelon),	Planting *Ajambari* on existing spurs	Installation of demonstration treadle pumps, provision of drinking water where tubewells are contaminated with arsenic	Self-help groups, savings and credit, community groups	Exchange visits to communities where farming on land affected by sand deposition is currently tried	Savings and credit group formation by cooperatives theme	Establish rain gauges at local schools and monitor daily rainfall. Transmit rainfall records to FM stations.
Bhasedwa	Promotion of sugarcane farming in areas likely affected by floods. New crops in areas affected by sand deposition (e.g. banana, guava, watermelon). House wiring	Planting trees along the floodplains and planting *Ajambari* along spurs	Making life jackets with used mineral water bottles, construction of a demonstration toilet and sanitation awareness programmes, smokeless stoves, construction of platforms in existing tubewells, support for reviving existing tubewells, alternative water supply for areas contaminated by arsenic	Train local youths to become volunteers at times of disaster	Exchange visits to communities where farming on land affected by sand deposition is currently tried	Savings and credit group formation by cooperatives theme	Establish rain gauges at schools in the upstream catchment of Lal-Bakaiya and monitor daily rainfall. Transmit rainfall records to FM stations, set up CDMA phones
Brahmapuri	New crops in land affected by sand casting (e.g. banana, guava, watermelon)	Planting trees along the Bagmati River embankment, planting *Ajambari* on existing spurs	Construction of a demonstration toilet and sanitation awareness programmes, smokeless stoves, construction of platforms in existing tubewells, support for reviving existing tubewells	Train local youths to become volunteers at times of disaster	Street theatres to demonstrate ways to protect oneself and property during floods. Training to work as reporters (especially for those who manage information centres)	Savings and credit group formation by cooperatives theme	Establish a warning system linked with the Karmaiya barrage regulating office, establish a communication centre

TABLE B | Adaptation Matrix for Nepal Sites: Underlying System for Adaptation

VDC	Education	Transport	Organisation	Livelihood	Communication
Rampur Khadauna	Training, advocacy, adult education, school support activities, scholarships for poor children	Wooden or plastic boats, temporary boats made of banana trunks and bamboo or inflated tubes	Network with organisations such as Oxfam, Nepal Red Cross Society and Dipecho supported programmes	Bicycle repair shops	Discussion platforms for policy issues, listeners' clubs
Devgaun			The village is considered a vegetable farming pocket. Organise exchange visits to promote different varieties of vegetables	Candlestick making, incense stick making, bicycle/motorbike repairing	Setting up of listeners' clubs
Bhasedwa		Use inflated tubes, rafts made out of banana trees/dried bamboo etc. to be used during times of inundation		Train local entrepreneurs to cast rings for toilet vaults and set up sani-marts	
Brahmapuri		Use inflated tubes, rafts made out of banana trees/dried bamboo etc. to be used during times of inundation	Networking among different groups formed by Dipecho, CPDR, Lutheran, Oxfam and Nepal Red Cross Society	Train local entrepreneurs to cast rings for toilet vaults and set up sani-marts	Set up mechanisms for communicating seasonal market prices at different bazaars for select commodities

Disasters can be used as opportunities for creating new avenues to allow vulnerable groups to reduce their vulnerability.

Keywords: Floods, Marginal Rivers, Disaster Risk Reduction, Climate Adaptation, Nepal Tarai, Himalaya-Ganga, North Gangetic Plains.

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The Larger Context

The summary of the fourth IPCC report (2007) states that "With regard to changes in snow, ice and frozen ground (including permafrost), there is high confidence that based on growing evidence the following types of hydrological changes will take place:"

> "Increased run-off and earlier spring peak discharge in many glacier- and snow-fed rivers." (p. 3)

Changes in precipitation will necessarily change the flow of rivers and thereby the likelihood of flooding.

Referring to the Himalaya region in particular the report continues:

> "Glacier melt is projected to increase flooding, rock avalanches from destabilised slopes, and affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. (p. 10)
>
> Heavy precipitation events, which are very likely to increase in frequency, will augment flood risk. (p. 7)
>
> In the course of the century, water supplies stored in glaciers and snow cover are projected to decline, reducing water availability in regions supplied by melt water from major mountain ranges, where more than one-sixth of the world population currently lives. (p. 7)
>
> Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emission scenarios by 2080)." (p. 11)

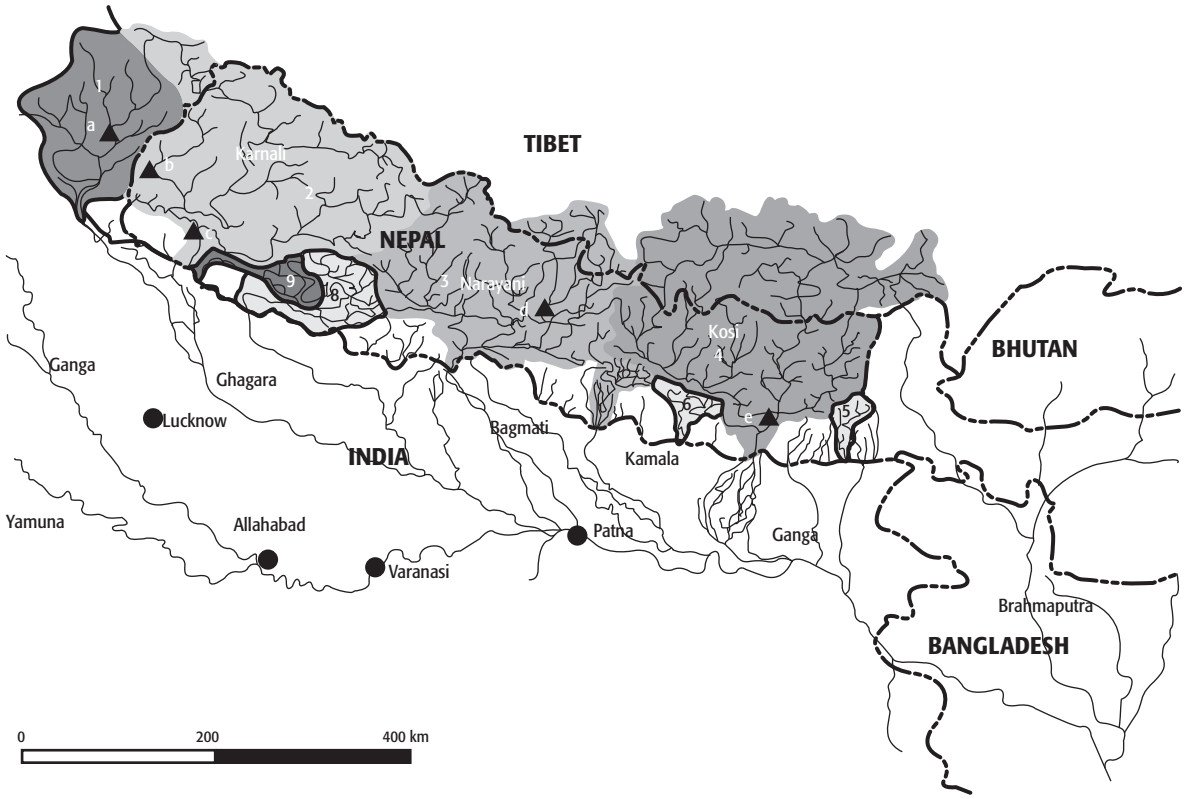
Current projections by the IPCC indicate that average precipitation levels in the Ganga Basin will increase by about 20%, and climate change projections indicate that variability and the frequency and intensity of extreme weather events such as large storms are also likely to increase. Climate change will not only affect the region's hydrology, but also alter temperature regimes, wind patterns, and storm tracks. In addition, land use patterns and aerosol pollution will directly affect local weather patterns. Impacts on the types of crops planted, the type and extent of vegetation coverage, and urban island heat effects will be significant. Changes in precipitation will necessarily alter the flow of rivers and thereby the likelihood of flooding. Paradoxically, while floods will be of greater magnitude, so, too will the incidence of drought conditions.

What exactly the impact such changes will have on the Ganga Basin is not clear — though have an impact they will. The Ganga Basin is not a homogenous land system; instead, it encompasses a highland and lowland hydro-ecological system that analysts have defined as the Himalaya-Ganga (see Figure 1 for a schematic diagram of the Himalaya-Ganga and the northern Ganga Basin). The system consists of diverse ecological zones and includes hundreds of ethnic groups that speak different languages.[1]

The highland and lowland system in the Ganga Basin encompasses Nepal, India

[1] For a discussion on Himalaya-Ganga see Gyawali and Dixit (1994).

FIGURE 1 | The Himalaya-Ganga region and river systems



and Bangladesh. The people living in this region are among the poorest in the world. Their impoverished living conditions are often attributed to the regular floods which occur during the monsoon seasons (June-September) and to the drought-like conditions that prevail after the monsoon rains are over (Bandhyopadhyaya, 1999). This flood-drought regime is the natural outcome of the region's climate and hydrology. Since the climate and hydrology of the region exhibit micro-level variations, their impacts will differ.

Although the monsoon rains are crucial for sustaining agriculture in the Himalaya-Ganga region, they are also a major hazard. After the onset of the monsoon in June, rains saturate the moisture-deficit landscapes promoting the growth of vegetation and crops and, consequently ensuring the success of people's agriculture-based livelihoods. A few weeks after their onset, these same life giving rains are responsible for widespread flooding. Cloudbursts, landslides, mass movements, mudflow and flash floods are common in the mountains, while in the plains of southern Nepal, northern Uttar Pradesh, Bihar, West Bengal and Bangladesh rivers augmented by monsoon rains overflow their banks. Sediment eroded from the upper regions of rivers is transported to their lower reaches and deposited on the flood plains of valleys and the Tarai. Rivers cut their banks and shift laterally, creating serious problems as people lose their land and

In the Himalaya-Ganga region the monsoon rains sustain agriculture but are a devastating hazard.

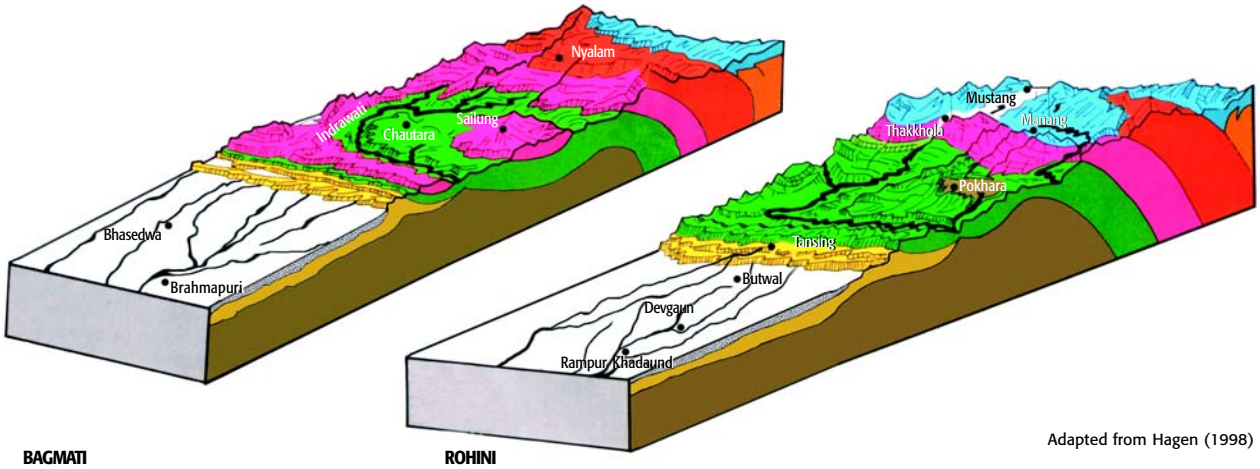
their crops, the very basis of their livelihoods. People and communities have developed livelihood systems that are adapted to such disruptions. They take advantage of the fine sediment brought by floods which increases agriculture productivity, and struggle to move the large sized sediment deposits. People face significant problems when sedimentation blocks watercourses causing stagnant water or when swollen rivers inundate the land — but when social and economic continuity is disrupted people cope. In recent years, however, these natural processes have changed due to the impacts of human interventions and it has become more difficult for people to adapt successfully. The building of embankments for flood protection, for example, obstructs tributary rivers and by blocking drainage can extend flood periods. Furthermore, because embankments are poorly maintained they frequently breach bringing large tracts of land under inundation and causing sand deposition. In short, interventions often contribute to rather than prevent flood disasters.

Rivers feed regional groundwater aquifers, serve many irrigation systems, and maintain ecosystems but are also the source of floods.

Tributaries and streams serve as a hydrological link between the upper and lower regions of Himalaya-Ganga. They also function as drainage channels transferring large volume of water received during the monsoon in upland regions, plain catchments and in delta regions to the ocean. The region's rivers constitute a densely-packed network of streams: In fact, its river drainage density of 0.3 km / km^2 reflects just how close the drainage channels are (Shankar, 1985). Nepal alone has more than 6,000 rivers totaling about 45,000 km in length. The tributaries of the Ganga River in Nepal contribute 71 % of its natural historic dry season flow and 41 % of its total annual flow. The rivers of the Ganga Basin are both a boon and a bane to the population of the region: while they feed regional groundwater aquifers, serve many irrigation systems and maintain ecosystems, monsoon flooding in these very rivers brings widespread devastation.

The rivers of Nepal can be classified broadly on the basis of their dry season flow as Himalayan, Mahabahrat and Chure. The four major Himalayan rivers (the Kosi, the Gandaki, the Karnali and the Mahakali) exhibit a sustained dry season flow derived from snow and

FIGURE 2 | The hill plain composite showing portion of Bagmati and Rohini basins



Adapted from Hagen (1998)

glacier melt. According to Sharma (1977), snowmelt in Nepal begins in March and continues till August, when monsoon rains also add to the flow. The seven Mahabharat rivers originate below the snowline in the middle hills and drain the region located between the Himalayan basins. They are spring-fed and augmented by the monsoon rains. The third type of rivers originates in the Chure range and run parallel to the Himalaya. Composed of fluvial deposits of the Neogene age (Upreti and Dhital, 1995) the Chure range is the active stage of the tectonic movement of the lower Himalaya (Hagen, 1998) and is made up of debris eroded over the last 40 million years. Its elevation varies from 150 to 1,800 meters. The hydrology of the several Chure rivers is characterised by individual peaks, a fact suggesting that their discharge is highly influenced by rainfall. When there is no rainfall, these rivers exhibit very low flow, almost zero in the upper reaches. In the lower reaches, however, groundwater and base flow and contribute to flow and these reaches may contain significant discharge even in the dry season. The flow of these rivers usually peaks in July or August, but the exact timing depends on the volume of rainfall. Because slopes are steep, Chure rivers flow with high velocities until they reach the Tarai, where the high energy generated is dissipated as rivers form meanders once they emerge onto the plains. The nature of the riverbeds and the pattern of channels of a Chure river vary according to its reaches. In the upper reaches, the steep slope bank-cutting and mass movement processes result in a high sediment load. In the Tarai, the same rivers will meander and change course. The hydrological characteristic of these rivers have not been studied in detail and their flooding results in more damage and devastation than is thus far understood while they collectively cause more devastation than the other two types. Despite their hazardous nature, these rivers are not on the radar screen of the national governments of the region, which instead focus their attention on the major tributaries of the Ganga River i.e. the first and second

Most smaller rivers are not on the radar screen of the national governments but are the locus of major flood events.

Flash flood is a major hazard in valleys of the mountains.

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type rivers. The Chure rivers are termed marginalised rivers. This definition emerged in the Duryog Nivaran meeting in Dhaka in 1995.[2]

Chure rivers flow first across the Nepal Tarai and then across the contiguous landmass of Uttar Pradesh, Bihar, and West Bengal. Their catchments extend from Uttar Pradesh in the northwest to the Darjeeling hills in the east and the Ganga River in the south and have an area of about 80,000 km^2. The area is crisscrossed by hundreds of a third type of river. In Nepal, the Chure rivers drain a total of around 18,860 km^2 consisting of the Chure range and the Tarai. The catchments of most individual Chure rivers are generally less than 350 km^2. These rivers are used extensively for irrigation and thus support agriculture, the local economy and community livelihoods. Using pumps and wells the contiguous groundwater aquifers are drawn on to meet drinking and irrigation needs. As these rivers flow from Nepal to India, they acquire a trans-boundary character.

The recession of glaciers in the Himalaya range will affect the overall water balance in the respective basins but the exact nature of its impact needs more investigation.

The Tarai region of Nepal is an extension of the Gangetic plain. Together they are home to millions of people who practice agriculture-based livelihoods. In the last five decades, the region has witnessed tremendous growth in infrastructure development. Roads, irrigation canals, railway lines, flood control embankments and urbanisation have all constrained drainage and thereby further exacerbated the impact of flooding. Both, the Nepal Tarai and the Gangetic plain are somewhat isolated from technological and economic globalisation but nonetheless are affected indirectly. In particular, commuting and migrating to seek employment have reshaped livelihood systems while the social and political communication systems are undergoing rapid changes. Such changes add new layers to the people's ability to adapt to the regular occurrence of flood and drought.

As mentioned above, the impacts of hydro-meteorological hazards induced by climate change need to be disaggregated according to ecological zone. Each region, the plains, the hills and the mountains must be viewed differently in order to assess critical impacts. The recession of glaciers in the Himalaya range, for example, will affect the overall water balance in the respective basins but the exact nature of its impact needs more investigation. Glacial melt may further exacerbate the risk associated with Glacial Lake Outburst Floods (GLOFs). Other differences include the fact that Nepal's western hills and Tarai experience more days without rainfall than the eastern hills and the eastern Tarai. At the same time landslides, mud flows, debris flows and *bishyari* (landslides into rivers) are common in the middle mountains. Floods inundate areas in the Tarai, where instances of bank-cutting and sediment deposition on productive land may increase.

This paper explores the nature of flood disasters in two regions in the Nepal Tarai. It presents our experiences in assessing flood hazard and vulnerability in selected village development committees (VDCs) with the objective of piloting disaster risk reduction activities and adaptation plans.

[2] BDPF, Duryog Nivaran and BUET (1995)

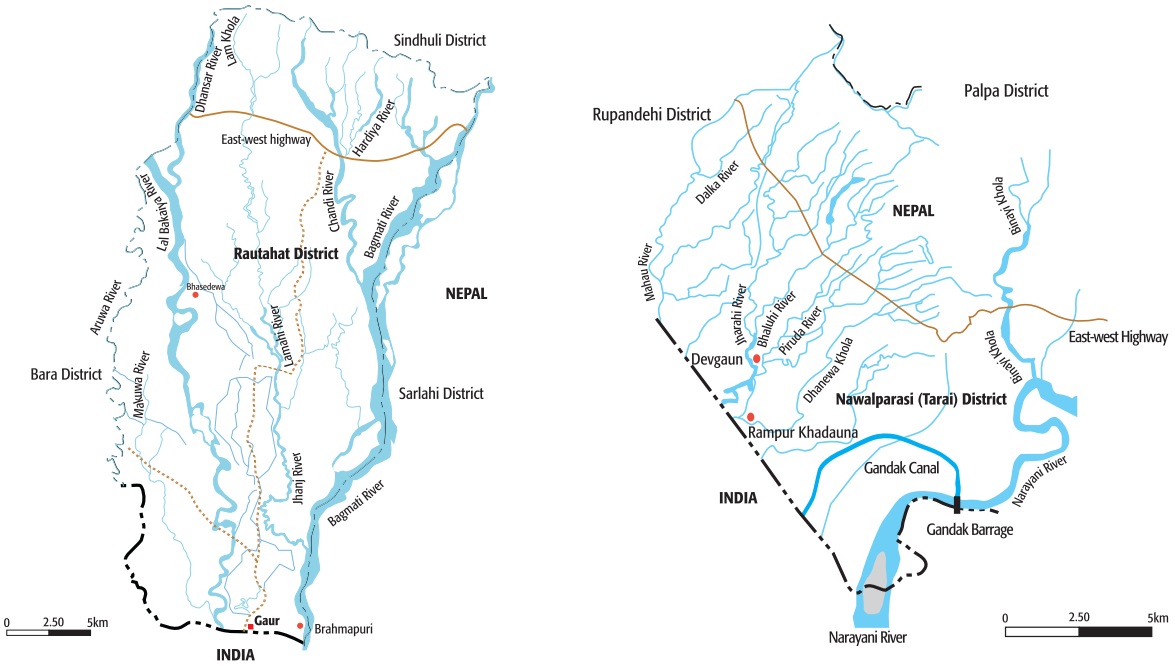
Study VDCs

The study includes a series of case studies and investigations of two districts of the Nepal Tarai, which are susceptible to flooding. The study sites are situated in the lower Bagmati and the Rohini river basins. Our earlier adaptive study project (Moench and Dixit, 2004) was based on empirical evidence collected in eight VDCs. It focused on the situation in the head, middle and tail reaches of the two basins.[3] Altogether 1,008 households were surveyed then. For the current adaptation / DRR pilot phase, the selection of VDCs was based on the following criteria.

- Presence of a partner organisation,[4]
- Incidence of human induced flood hazards and
- Characteristics of the rivers.

On the basis of the above criteria, four VDCs, two in each river basin were selected, Rampur Khaduana and Devgaun in Rohini Basin, and Bhasedwa and Brahmapuri in Bagmati Basin. The latter two villages are located in the *doab* (between river areas) of the Bagmati and Lal Bakaiya rivers in Rautahat District, while Rampur Khadauna and Devgaun are located in Nawalparasi District of Nepal (Figure 3).

FIGURE 3 | Rautahat and Nawalparasi (Tarai) districts along Bagmati and Rohini rivers



[3] See Moench and Dixit (2004). Poudel *et al.* (2004) has done a study of flood hazard in Rautahat District.

[4] The boundary partners of the study are the Center for Disaster Mitigation (CDM) and the Support Oriented Organisation (SOS) and the Community Support Organisation (CSO).

The findings about these VDCs are expected to help in the development of adaptation plans and in the implementation of selected key measures which will serve as pilot activities in disaster risk reduction.

Monsoon rainfall is the primary cause of flooding in all four VDCs, which as a result experience inundation, bank-cutting and sand deposition. In Rampur Khaduana, drainage congestion exacerbates the adverse effect, while in Brahmapuri, embankments built in the state of Bihar along the border of Nepal and also along the lower reaches of the Bagmati River in Nepal have a similar result. The VDCs studied are indicated in Figure 3. The VDCs in the Rohini Basin are located upstream of the study villages in Eastern Uttar Pradesh.

Drainage congestion exacerbates flood effects.

Nature of Hazard

All three types of rivers discussed above have contributed to flooding in the Himalaya-Ganga since time immemorial. Widespread damage over the last century was caused by numerous floods including those in 1927, 1954, and 1972. More recent flood disasters took place in 1987 and 1988 in Bangladesh, in 1993, in the Bagmati River of Nepal and in 1998, in parts of Nepal and Eastern Uttar Pradesh which drain the Rohini River, Bihar, West Bengal and Bangladesh The monsoon of 2007 has also resulted in widespread flooding and brought devastation on a large scale in Nepal, India and Bangladesh. This flood was caused by excessive rain but specific details, such as, those about the nature and magnitude of the rains have yet to be analysed. In the following sections, we highlight the impacts of the 1993 and 1998 floods.

1993 Bagmati Flood

In 1993, central Nepal received very high rainfall because of a low monsoon weather system. This affected the catchments of Agra, Belkhu, Malekhu, and Mahesh kholas, which drain the northern Mahabharat face, as well as the Jurikhet, Mandu, Manahari, Lothar and Rapti kholas, which drain the southern face. These sub-basins are located in the Gandaki River system. The Kulekhani river in the Mahabharat range flowed into the Bagmati before the Kulekhani Hydroelectric Project was completed in 1981. The cloudburst also affected this project. The storm then moved eastward and settled over Ghantemadi in the catchments of Marin and Kokajhar kholas of Sindhuli District in the Bagmati Basin (MOWR, 1993). Both are tributaries of the Bagmati River. A station in Tistung in the Kulekhani catchment recorded 540 mm of rainfall in 24-hours on July 19, the maximum 24-hour rainfall ever recorded in the history of Nepal. The resultant massive swelling of the Bagmati and its tributaries caused major flood devastation in the mid-hills and the lower Bagmati Basin. It severely damaged the Bagmati barrage, its equipment, its gate control system, sections of the main canal, and the housing colony for staff.

The flooding in the Agra, Belkhu and Malekhu kholas of the Gandaki River system had a devastating impact on their watersheds, while the washing out of the bridges along the Prithvi Highway isolated the capital Kathmandu from the Tarai. When the flooding in the Jurikhet khola severed the penstock pipe of the Kulekhani HEP, the country lost almost half its total installed electricity capacity from the Integrated Nepal Power System (INPS).

TABLE 1 | Loss of Life and Property due to 1993 Floods in the Bagmati Basin

District loss	Affected		Death	Houses damaged		Land loss	Livestock loss	Infrastrctures					Food grain loss	Total Worth (NRs)
	HHs	Popn.		Completely	Partially	(area in ha)	(Km)	Road	Bridge	Dam	FMIS building	Public		
Bhaktapur														
Kathmandu	10	58*	2	8	0	3	159	0	0	0	0	0	0	867,274,750
Lalitpur	0	0	6	57	51	135	0	0	1	0	1	0	0	**
Makwanpur	14,748	101,482	242	1,732	1,879	4,656	665	7.92	16	1	251	118		119,864,381
Kavre	2,958	10,642	20	914	92	1,030	159	0	0	0	0	0	0	86,274,750
Sindhuli	11,051	59,142	52	1,206	1,314	4,061	1,930	26	41	5	6	24	1,186	86,349,764
Rautahat	14,644	89,146	111	2,003	4,541	1,366	3,211	40	13	0	1	37	31,673	899,680,261
Sarlahi	15,560	83,265	687	7,066	8,494	25,966	17,736	266	81	4	117	184	0	1,118,918,500

Note * Generated data
** Missing data

Source: Developed from Photo Album, Disaster of July 1993 in Nepal, December DPTC (1993)

As a result of the floods, about 1,300 people died nation-wide with about 111 from Rautahat District. In all, 73,606 families were affected and 39,043 houses were fully or partially damaged. About 43,330 hectares of fertile land was washed away by floods or covered by landslide debris and 367 kilometres of the road that connected the capital with the Tarai and its retaining structures were damaged. Six major bridges and twenty-five culverts were damaged or washed away. In addition, approximately 37 large and small irrigation systems and thousands of farmer managed schemes were damaged. Furthermore, 213 wooden and suspension bridges were washed away. Altogether 452 schools, health posts and government buildings were damaged (DPTC, 1993). The extent of loss is shown in Table 1.

1998 Rohini Flood

The 1998 monsoon rains in the Rohini Basin arrived during the last week of June and were fully established by the beginning of July. The monsoon began in the lower catchment of the basin and spread over the foothills of the upper catchment in the north. The months of July and August 1998 were exceptionally wet, with both the upper and lower regions receiving high rainfall. In addition, several cloudbursts also occurred, particularly in the upper catchment where the number of cloudbursts and wet days was greater than it was in the lower catchments. In fact, the rainfall in the region was three times higher than the normal. According to the Meteorological Department, the total rainfall in Gorakhpur as of August 20 was 1,232 mm, a record in and of itself. Then, on August 24, a record rainfall of 460 mm in 24-hours fell.

Upper catchments experience major cloudburst events.

The impact of the flood was not limited to Parasi and Eastern Uttar Pradesh; it also caused widespread damage in Bihar, West Bengal and Bangladesh. According to the un-starred questions in the *Rajaya Sabha*, India lost 1.393 million ha of crops, a total comprised of 1.224 million ha in Bihar, and 0.131 million ha in West Bengal. The damage in Bangladesh was still more devastating. Almost two-thirds of the country (100,000 km^2) was submerged. The inundation continued for 65 days, marooning 33 million people, of whom 18 million needed emergency food and

Blocked aqueduct causes drainage congestion.

The 1998 flood was caused an exceptionally wet monsoon in conjunction with a major cloudburst.

health services (Ahmed, 1999). The flood caused serious damage in Dhaka, seriously affecting the health, housing, food, security, employment, communications and livelihood of the urban population (Nishat *et al.*, 2000). The rainfall recorded in 1998 was among the highest recorded in recent times but could be a regular event in the natural cycle of the region. However, since rainfall events have not been monitored on a long-term basis it is difficult to draw conclusions regarding trends or changes in periodicity and attribute them to impacts of global climate change. The flood affected 279 families in different parts of Nawalparasi District. It washed away about 24 hectares of land and damaged property worth over Rs. 680,000. Because of the low gradient in the lower region, inundation was widespread and long-lasting. The havoc created in the *doab*[5] life was widely reported in the local media. From the first week of July till the end of August, death, inundation, house collapse, cutting of banks, breaching of embankments, blanketing of land with sand, disease and damage to infrastructure, including roads, bridges and power lines prevailed.

In Uttar Pradesh, the districts of Gorakhpur, Gonda, Baharaich, Sravasti and Balarampur Siddharthanagar were affected. Floodwaters disrupted road and train services. About 1,300 people

[5] For details, see Report on Eastern Uttar Pradesh Flood by People Commission (1998).

TABLE 2 | Loss of Life and Property due to 1993 Floods in the Rohini Basin

District loss	Affected		Death	Houses damaged		Land loss (area in ha)	Livestock loss (Km)	Infrastrctures					Food grain loss	Total Worth (NRs)
	HHs	Popn.		Completely	Partially			Road	Bridge	Dam	FMIS building	Public		
Nawaparasi	279	1,604*	***	2	**	24.04	0	**	**	**	**	**	**	680,000
Rupandehi	1,446	8,315*	18	128	**	0.14	1	**	**	**	**	**	**	68,190,300

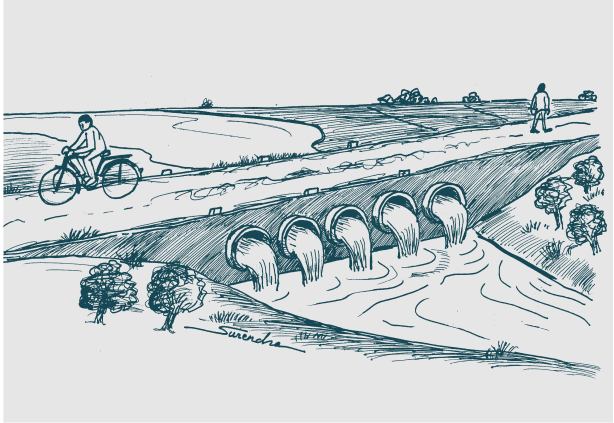
Note * Generated data
** Missing data
*** Not clear whether there were no deaths or the data is missing. Ethno-history of two study VDCs does not report any deaths.

Source: Developed from Photo Album, Disaster of July 1993 in Nepal, December DPTC (1993)

and an estimated 2,800 livestock died in the districts of Gorkhapur, Maharajgunj, Deoria and Kushinagar. Gorakhpur became an island after blocked the road that linked the city to other cities. Nearly 95 % of the affected dwellings were huts. In most of the affected villages floodwaters remained for three months. Sand deposition affected 11,253 ha of land in 148 villages; the depth of the sediment deposited ranged from one to seven feet. Water-borne diseases caused additional deaths.

The 1998 flood was not an aberration. Nine years later, in 2007, the region faced a similar situation as flood waters caused by the monsoon rains swept the South Asian landscape. In parts of the Ganga Basin in Nepal, India and Bangladesh, flooding inundated large areas, killed hundreds and displaced millions. Agricultural and other losses were high but are still being assessed. Disease has spread throughout much of the flood-affected region, affecting both rural and urban populations. The monsoon flood of 2007, although above long-term averages, is far from unprecedented. Indeed, floods are a regular feature of life in the basin, important for soil fertility, aquifer recharge, and a healthy regional ecology. As the misery of so many inhabitants of the basin clearly demonstrates, current approaches to flood management are unable to mitigate the impacts on human lives and livelihoods. If climate change projections prove accurate and flood events become more frequent or extreme, this inadequacy will increase.

Climate change will alter flood hazards and probably increase them.



Natural and Social Characteristics of the VDCs Studied

In order to examine the context of flood hazard and vulnerability, we examined the natural and social characteristics of the case study sites.

Floods lead to inundation bank cutting and sand deposition.

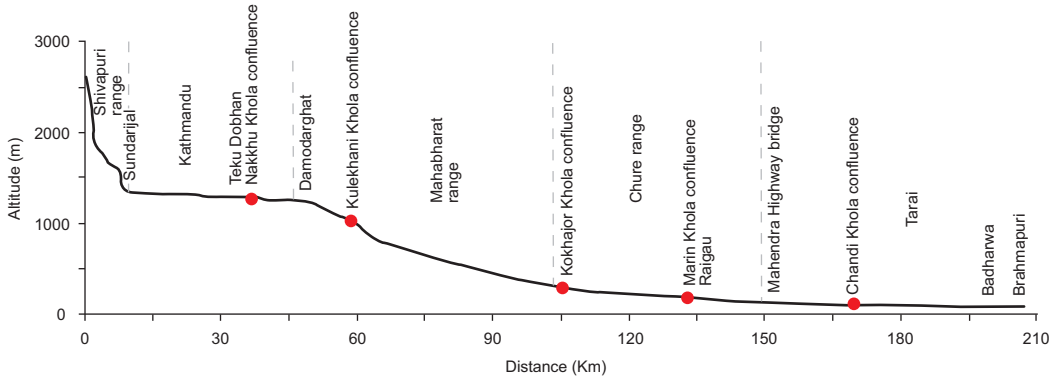
Natural Characteristics

Bagmati Basin

The Bagmati River Basin in central Nepal covers an area of about 3,750 km^2. The river's watershed includes parts of eight districts: Kathmandu, Lalitpur, Bhaktapur, Makwanpur, Kabhre, Sindhuli, Rautahat, and Sarlahi. The Bagmati River begins north of Kathmandu, at Shivapuri, and drains out of Nepal into Bihar, where it joins the Kosi River near Badla Ghat in Khagaria before joining Ganga River. Nakkhu, Kulekhani, Kokhajor, Marin, Lal Bakaiya and Chandi are its major tributaries. The two study villages are located in the *doab* of the Bagmati and Lal Bakaiya rivers.

The Lal Bakaiya River begins in a small *dun* (valley) of Makwanpur District and flows to Rautahat District before joining the Bagmati in Bihar a few kilometers downstream of the Nepal-India border. In Makwanpur Districts, it is called Bakaiya, but when it reaches the Tarai and takes on a reddish tinge from the soil of the Chure range it is known as Lal Bakaiya. The catchment area of the Lal Bakaiya River is 168.75 Km^2, and its average high flood discharge during the monsoon is 2,365 m^3/s at Karmaiya. Though its catchment is five-times smaller than that of the Bagmati River, Lal Bakaiya causes more damage. Floods in the river last for just four or five hours but river flow is flashy and brings a lot of sediment load. Bank-cutting and sand deposition are common in adjoining VDCs. Lal Bakaiya, as well as the Lakhandehi, Ratu, Jhanj, Kalinjor and Fuljor rivers drains the Chure range and the Nepal Tarai before joining the Bagmati in Bihar, but the catchment areas of these rivers are not included in that of the Bagmati River in Nepal.

FIGURE 4 | Profile of Bagmati river



Note: The red dots in the profile indicate points where tributaries join the Bagmati River.

Source: DWIDP (2005)

FIGURE 5 | Schematic view of Bagmati and Lal Bakaiya rivers and dependent area

Flooding within the lower Bagmati *doab*, where the river gradient is about four-meters per kilometer, is a consequence of morphological disruptions in the Bagmati and the Lal Bakaiya. Both rivers are embanked and extend far into Nepali territory. Bairgaina Block of Bihar is situated between the Bagmati and Lal Bakaiya rivers and borders Rautahat District of Nepal. The entire block is surrounded by embankments in a structure known as a 'garland embankment'. The northern portion of this embankment runs parallel to the Nepal-India border, obstructing natural drainage. As a result, the river floods areas within Nepal, including Gaur Municipality and Brahmapuri VDC.

Rohini Basin

The Rohini is a tributary of the West Rapti River, which in turn flows into the Gandak River north of Gorakhapur. Though it begins in the Chure, the river crosses the Indian border after draining parts of Rupandehi and Nawalparasi districts. Most of the area it drains is in the 1,960 km^2 district of Nawalparasi, which has four distinct geographical zones: the hills, the inner Tarai, the Chure and the Tarai. The Parasi plain is a continuation of the north Gangetic land system. In Nepal, the average north-south width of the Tarai plain varies between five and 40 km. The catchment area of Rohini lies between the municipality of Butwal in

Embankments constrain natural drainage.

Chure rivers are flashy in nature.

Rupandehi and the Daunne hills of Nawalparasi District. The eastern part of Butwal located in the watershed of the Tinau River also drains into the Rohini. Thus, the Rohini and its tributaries drain the area lying between the Narayani (the Gandak) River in the east and the Tinau River in the west. Its main stem begins at Chauranghi in the Chure hill and flows into the basin's western section. A number of tributaries (*nala*, *kholsa*, *khahare*, khola and streams) flow into the main-stem as it flows south. As they flow, the tributaries change course, split into distributaries and captures neighbouring streams. In Nepal, the tributaries of the Rohini are the Jharahi, Dhanewa, Bhumahi, Bhaluhi and the Somnath. Each begin as an ephemeral stream (*khahare)* on the southern slope of the Chure and later joins the Rohini before that river enters Uttar Pradesh at Mishrauli of Nautanawa Block.

Of the Rohini's total length of 122 km, 43 km lies in the *bhabar* and upper Tarai of Nepal; the rest is in India. The Rohini has a total catchment area of 2,686 km^2, 794 km^2 (30 %) of which is in Nepal. This 30 % contributes more run off than that generated within the lower catchment in India, because the catchment in Nepal receives more rainfall. Of the total area in Nepal, 505 km^2 is in Parasi District and 289 km^2 in Rupandehi. The Rohini River system and its tributaries drain almost all of the Parasi Tarai. The Jharahi and Dhanewa rivers join each other after they flow into India and together are called the Chandan River. With its tributaries from Nepal and Uttar Pradesh, the Rohini joins the West Rapti River near Gorakhpur. The drainage area of the river in the plains of both Nepal and Uttar Pradesh is contiguous to that of the Tinau (called the Kuda in Uttar Pradesh) in the west and the Gandak in the east.

The slopes of the Rohini River and its tributaries change within a few kilometres of their origin in the Chure range. Because the gradient is low, they have a tendency to meander and deposit sediment. Even though the slope is high, sediment deposition is greater in the upper reaches because the bulk of the sediment is derived from mass wasting, and consists of cobbles and pebbles, which readily settle out. Finer sediment, in contrast, moves further downstream. The lower reaches of the Rohini receive sediment from the upstream sections as well as from the erosion of bed and banks. With the cessation of rainfall, flow velocity reduces and large amounts of sediment begin to be deposited in the riverbed and on flood plains, while suspended loads are transferred still further downstream. In the lower reaches because the stream gradient is less than 0.1, the effects of floods are severe.

TABLE 3 | Summary of Characteristics

Characteristic	Bagmati Basin		Rohini Basin
	Bagmati River	Lal Bakaiya River	
Area (km^2)	3,750	806	194
Length (km)	207	116	The longest main within Nepal is 43 km.
Maximum Elevation	2,716	2,135	Begins at 850m at Chure drops to 100 m.
Minimum Elevation	71	72	
District	Kathmandu, Lalitpur, Bhaktapur, Makwanpur, Kabhre, Sindhuli, Rautahat, and Sarlahi	Makwanpur, Bara, Rautahat	Nawalparasi and Rupandehi
Tributaries	Manahara, Bishnumati, Nakkhu, Marin, Kayan, Kokhajhor, Chandi, Manusmara	Lohajor, Bakaiya, Bunda, Hile, Majhi, Simat, Burani, Sukaura, Jyamire, Harda, Dhansar, Bhavar	Jharahi, Bhaluhi, Dhanewa

Social Characteristics

In the following sections, we discuss the socio-economic conditions of the four VDCs based on information collected at the ward level using tools such as transact walking and semi-structured interviews. Transects and interviews were conducted with local NGOs, CBOs and network staff and with volunteers to gather information about flood problems, as well as about adaptation strategies and their advantages and disadvantages.

The 20,399 inhabitants of the four VDCs live in 3,066 households, about the same number in each VDC. The two VDCs of Rohini Basin house 9,756, while those of the Bagmati Basin house 10,586. The economic status of the people is poor. For the most part, families suffer food shortages. In Devgaun, for instance, just 62 % of the population produces enough food for more than six months, while in Rampur Khadauna, Bhasedwa and Brahmapuri the equivalent figures are 69, 77, and 62 % respectively (Table 5).

As shown in Table 6, literacy rates in Brahmapuri, Bhasedwa, Rampur Khadauna and Devgaon VDCs are 34, 39, 52 and 49 % respectively. Literacy is higher in the two Rohini Basin VDCs than in the Bagmati Basin VDCs. In all VDCs female literacy is substantially lower than male.

Brahmapuri has the largest proportion (41 %) of landless households and Rampur Khadauna, the least (19 %). Between 9% and 14 % of landless households in the four VDCs rent land for agriculture purposes, while the remaining landless households earn a livelihood through daily wage labour. In Brahmapuri, only 27 % cultivate private lands, in all three other VDCS the proportion is 40 %. About 40 % of landowners rent their land to others.

TABLE 4 | Households, Population and Area of Study VDCs

District/VDC	Household (Nos)	Total Population	Male	Female	Area (km²)	Population density
Nawalparasi	98,340	562,870	278,257	284,613	1126	500
Devgaun	845	5,424	2,819	2,605	9.44	575
Rampur Khadauna	659	4,389	2,273	2,116	3.75	1,170
Rautahat	88,162	545,132	282,246	262,886	2162	252
Bhasedawa	935	6,254	3,252	3,002	9.75	641
Brahmapuri	627	4,332	2,230	2,102	9.19	471

Source: Field Survey (2006)

TABLE 5 | Household Food Sufficiency by Months

VDC		Not enough 3 months	Enough for 3 months	Enough for 6 months	Enough for 9 months	Enough for 12 months	Surplus HHs	Total HHs
Devgaun	Number	237	138	140	103	135	92	845
	Per cent	28	17	17	13	16	11	
Rampur Khadauna	Number	118	156	174	93	74	44	659
	Per cent	18	24	27	15	12	7	
Bhasedhwa	Number	404	199	97	136	60	39	935
	Per cent	44	22	11	15	7	5	
Brahmapuri	Number	258	152	90	72	37	18	627
	Per cent	42	25	15	12	6	3	
Total HHs								3,066

Source: Field Survey (2006)

The amount of land in the Bagmati Basin used for agriculture is decreasing, the amount in Rohini is constant, and in Rampur Khadauna it is increasing (See Figure 6 (a) and (b)).

We asked villagers to assess the impact of floods. Their responses are listed in Table 8. Villagers identify bank cutting, sand deposition and inundation as the main impacts.

TABLE 6 | Literacy Rate (%) (for Population 6 Years and Above)

VDC	Female		Male		Total	
	population	%	population	%	population	%
Devgaun	2,605	35	2,819	67	5,424	49
Rampur Khadauna	2,116	31	2,273	68	4,389	52
Bhasedhwa	3,002	20	3,252	44	6,254	34
Brahmapuri	2,102	28	2,230	52	4,332	41

Source: Field Survey (2006)

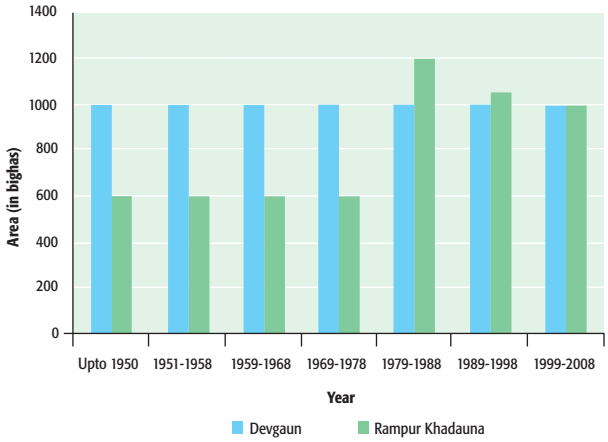
TABLE 7 | Land Tenure Type

VDC	Households under different land tenure					
	Own land cultivated	Rented to others	Own plus rented	Rented	Landless	Total households
Devgaun	335 (40)	83 (10)	224 (27)	107 (13)	96 (12)	845
Rampur Khadauna	263 (40)	66 (10)	210 (32)	64 (10)	56 (9)	659
Bhasedhwa	368 (40)	120 (13)	210 (23)	85 (9)	152 (17)	935
Brahmapuri	167 (27)	59 (10)	142 (23)	84 (14)	175 (27)	627

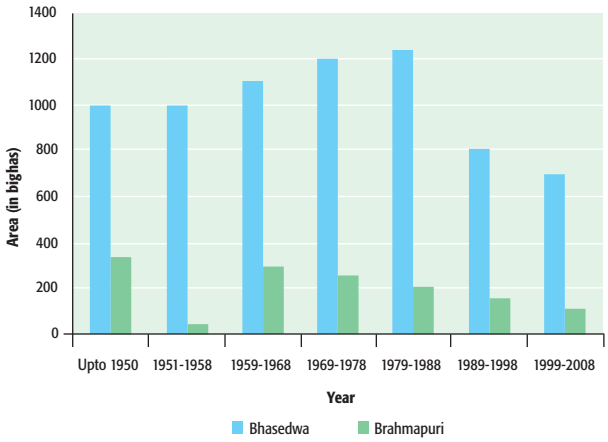
Source: Field Survey (2006)

FIGURE 6 | Status of agricultural land

a) Rohini Basin



b) Bagmati Basin



Assessing Context of Flooding

Since the objective of the study was to identify activities that would enable communities to adapt and to help disaster risk reduction, it adopted a bottom-up approach beginning with affected communities and backed up with insights from research and central-level functionaries. Primary information was generated through participatory rural appraisal (PRA) techniques and a household survey. The following specific methodologies were used.

1. Reconnaissance visits to the concerned districts, including the headwaters of the rivers
2. A social map of the hazards in each VDC was prepared and transposed on a topographical map (1:25,000) of the VDCs.
3. The number of households in the identified hazard zone was listed and their vulnerability assessed.
4. A time line recording trends was prepared
5. Individual-, local-, and national-level shared learning dialogues (SLDs) about people's perceptions of flooding, damage (land, crop, human life, animal life) and impact on pre-, during and post-flood situations were conducted.

Ethno-History and Trend Analysis

Before we discuss the state of vulnerability the affected and the results of the SLDs, it is useful to recount the ethno-history of flooding in the region. The analysis of floods in Bhasedwa and Bramhapuri VDCs of the Bagmati Basin shows that large-scale devastation occurs during extreme events such as the one in 1993, but that in other years as well, agricultural land is inundated and houses are damaged.

Rohini Basin

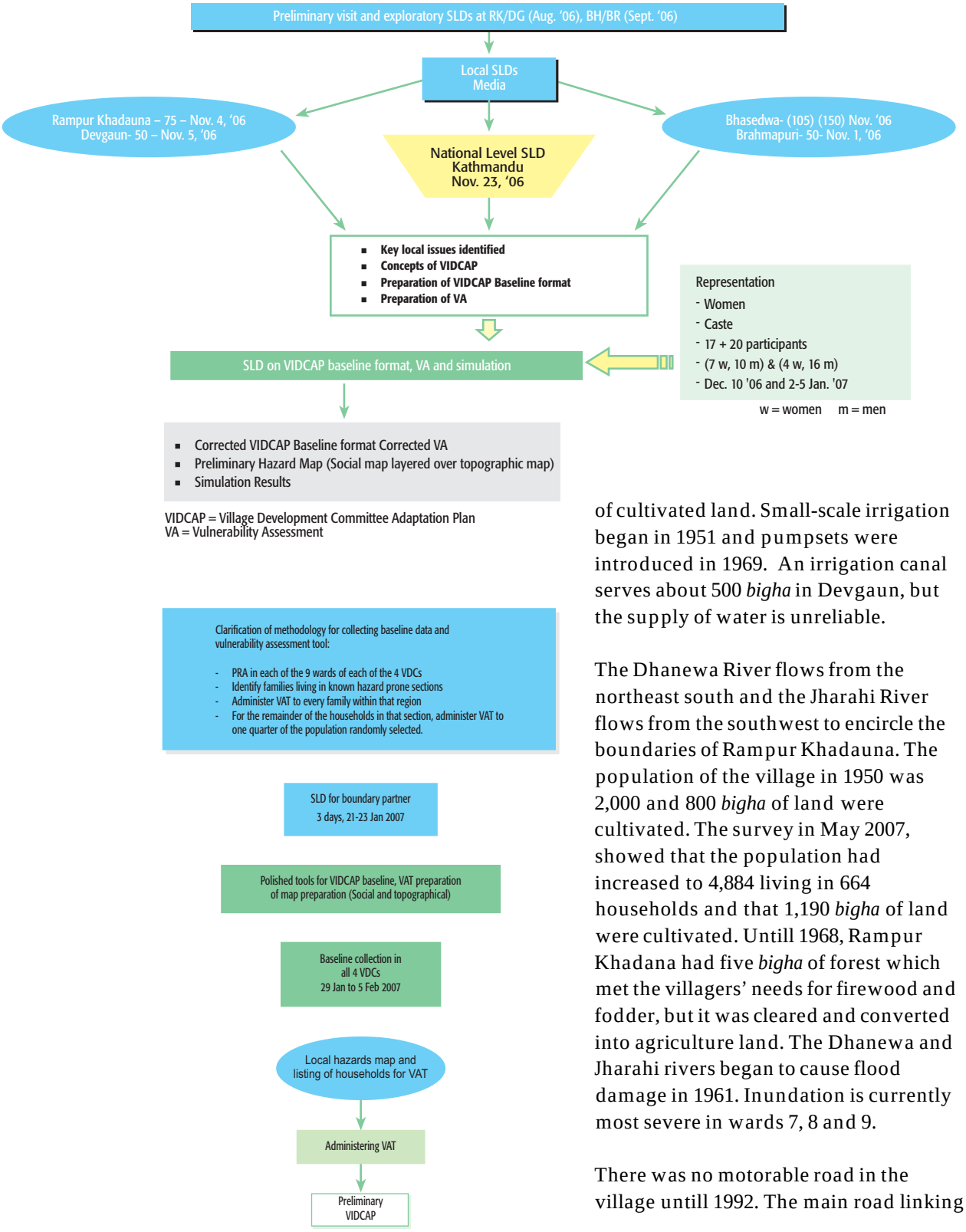
Historical analysis of floods, populations and natural resources in Rampur Khadauna and Devgaun VDCs of Nawalparasi, Rohini Basin shows that floods are neither sudden nor unexpected. Floods in the Piruda River in the northeast and the Bhaluhi River in the northwest damage cultivated land and crops in Devgaun VDCs. In 1950, 2,100 people lived in 400 homes and cultivated 1,000 *bigha* of land. The current population is 5,424 living in 841 households but they own only 993 *bigha*

TABLE 8 | Effects of Flood

VDC	Bank cutting		Sand deposition		Inundation		Property damage and loss of lives			
	Cultivable land	Other use	Cultivable land	Other use	Cultivable land	Other use	House	Cowshed	Human	Livestock
Devgaun	29	15.5	11	10	990	63	80	85		150
Rampur Khadauna	45				1,095		44	40		
Bhasedhawa	175	8	246	25	10		25	40	2	10
Brahmapuri	58		76		35		14	41	1	

Source: Field Survey (2006)

FIGURE 7 | Methodology schematic



of cultivated land. Small-scale irrigation began in 1951 and pumpsets were introduced in 1969. An irrigation canal serves about 500 *bigha* in Devgaun, but the supply of water is unreliable.

The Dhanewa River flows from the northeast south and the Jharahi River flows from the southwest to encircle the boundaries of Rampur Khadauna. The population of the village in 1950 was 2,000 and 800 *bigha* of land were cultivated. The survey in May 2007, showed that the population had increased to 4,884 living in 664 households and that 1,190 *bigha* of land were cultivated. Untill 1968, Rampur Khadana had five *bigha* of forest which met the villagers' needs for firewood and fodder, but it was cleared and converted into agriculture land. The Dhanewa and Jharahi rivers began to cause flood damage in 1961. Inundation is currently most severe in wards 7, 8 and 9.

There was no motorable road in the village untill 1992. The main road linking

Rampur Khadauna to Parasi is graveled while local roads are paved with bricks. Small drains were built in the VDC after 1993.

Local people mentioned that untill 1970 flooding improved productivity in some sections of Devgaun VDC. The river water brought clayey loam suitable for growing *rabi* crops such as *arahar* (yellow lentils), peas, gram and *masuro* (red lentils). Merchants from nearby Indian towns came to the village to buy the harvests. In the last thirty years, productivity has declined substantially and crops such as *arahar*, peas, *masuro* and gram are not grown anymore.

Bagmati Basin

Floods in the Lal Bakaiya River affect Bhasedwa while floods in the Bagmati River affect Bramhapuri. Each year both rivers create havoc during monsoon. The Bagmati has moved three kilometers westward in recent years resulting in a loss of land and depositing sand on a substantial area. Before 1969, villagers claim that floods were not a problem. In 1966, the Indian Railways diverted the Bagmati from its western to eastern channel in order to protect the railway lines. Wooden piles were dug and spurs constructed along the western channel. These interventions altered the local river dynamics and exacerbated the impacts of flooding on Bramhapuri.

About 100 households in Bramhapuri have been displaced in the last two decades and only 100 of 334 *bigha* of agriculture land remain. In Bhasedwa, about 600 households were displaced. About 700 *bigha* out of a total of 1,250 *bigha* is cultivated in Bhasedwa. In the decades of 1959-1968, 1969-1978 and 1979-1988, respectively 20, 30 and 200 *bigha* of forest was cleared in Bhasedwa.

TABLE 9 | SLD and Vulnerability Assessment Matrix

Step	Activity
I	Identification of VDCs representing head, tail strata of the river.
II	Identification of local hazards within each VDC.
III	Preparation of timeline and Ethno-history of floods.
IV	PRAs at ward level of four VDCs
V	Vulnerability Assessment in each VDC.

The figures indicate that the extent of deforestation has increased almost seven-fold after the floods in 1970 and 1975, which damaged 100 and 10 *bigha* of cultivated land respectively. Fifty households were displaced in 1978 and 50 *bigha* of land were destroyed between 1979 and 1988. During the 1993 floods 100 households were displaced and 40 *bigha* of cultivated land was damaged. Another 100 households were displaced and crops growing on 100 *bigha* were destroyed when the Bagmati canal embankment began breaching after 1999. The extent of flood devastation is perceived to be increasing and the communities lose cultivated land, crops, livestock and property each year. At the same time, the degradation of forest and grazing land is rapid.

In both basins floods are a regular phenomenon.

Embankment along Brahmapuri.

© A Pokhrel

TABLE 10 | Ethno-History of Floods in Devgaun

Year	Event
1969	10 *kattha* of land affected by bank cutting. Floods inundated ward numbers 1, 3 and 4. Flood waters also brought clayey loam increasing productivity.
1970	Ward numbers 2, 5 and 6 were inundated.
1990	Water from Bhaluwai and Piruda rivers inundated the village. Water released in the Gandak canal exacerbated the problem because cross drainage structures have insufficient water way. The settlement of ward number 7 and 8 were affected and the crops destroyed.
1996	The river washed two spurs in ward number 1 displacing 5 houses of Yadav Gaon. Those displaced live close to the *Hulaki Sadak.*
1998	All settlements of ward numbers 1, 2, 7 and 8 and the cropped areas were affected. In ward number 1, four *bighas* of land was destroyed by bank cutting while 10 households were displaced. They bought land in Sarawal VDC. Flood in Pidruda River resulted bank cutting in ward number 8 and washed away a Muslim graveyard (5 *bigha* of land). Sand deposition affected eight *bigha* of land In ward number 4.
2003	Floods inundated settlements of ward numbers 1, 7, 8 and all farmlands. Parts of ward number 9 was inundated. All crops destroyed. The productivity of land is decreasing.

FIGURE 8 | Flood hazard map of Devgaun

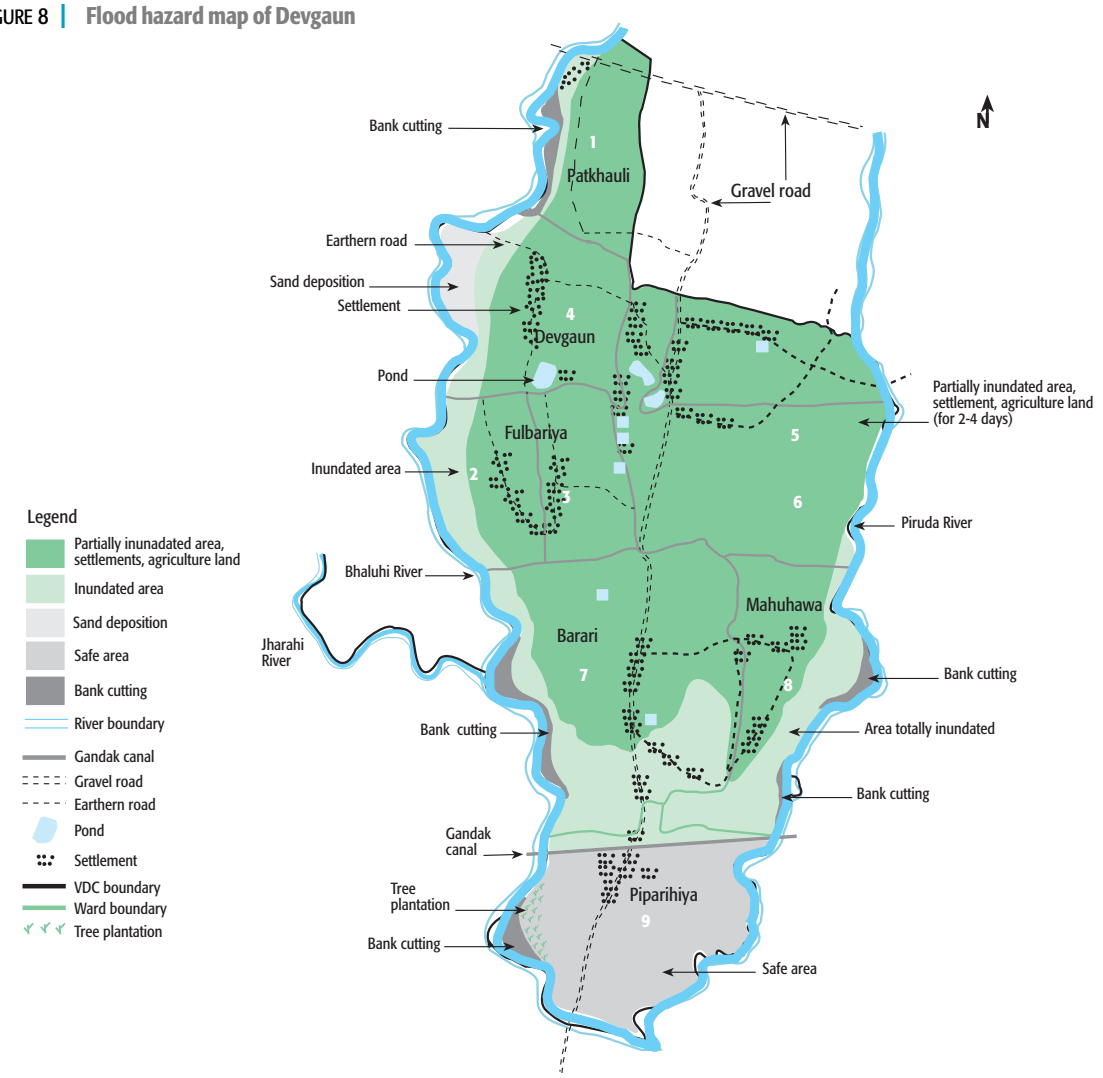


TABLE 11 | Ethno-History of Floods in Rampur Khadauna

Year	Event
1961	Early records of inundation in the village date back to this year. All houses of ward number 9 along with agriculture lands were under water. However, the flood was not devastating. It started receding after 10-12 hours. The flood deposited clayey loam over the fields. This resulted in a harvest boom for crops such as grams, lentils, peas and early paddy. The nature of flooding changed in the later years.
1979	Gandak Irrigation Canal was constructed during 1979-80. However, the area received irrigation only after 1984. The main canal runs perpendicular to the ground slope. Cross drainage structures were designed and implemented with insufficient water ways. This causes flooding in the settlements of ward numbers 7, 8 and 9. All crops in the fields were lost. Paddy seed had to be sown repeatedly. In some areas inundation was minor and paddy harvest was better.
1982	Two persons died in floods. The Dhanewa River gradually became larger and joined the Jharahi resulting a flooding. The settlements of ward 8 and 9 and all crops were submerged for 4 days. The Jharahi River changed course in 1961 after Sugauli Dam was constructed at Haripur VDC. Ward 1 and 2 were affected by bank cutting and inundation.
1990	The widening of Dhanewa River resulted in inundation of houses of ward numbers 7, 8 and 9 and all crops for 4-5 days. Gandak canal receives no water when required but in the monsoon excess water was released in the canal exacerbating flooding.
1991	Flood caused death of one person. Bank cutting by Dhanewa and Jharahi rivers was severe. No action was taken. Whenever there was rain in the northern catchment, people realised that flood will come after 1 or 2 days.
1996	Communities of ward numbers 1, 7, 8 and 9 are temporarily displaced. People took shelter at the school and returned to their homes only after water receded. The confluence of two rivers changed and altered the flooding pattern. The bed level also increased. Since river bed was higher than the fields, the flood water easily found its way into the fields. People from ward number 1 left their homes to live temporarily in ward numbers 3 and 4.
1998	The VDC was submerged. Crops in 1,000 *bigha* were destroyed.
2000	July floods inundated houses of ward numbers 7, 8 and 9. People along with their belongings and cattle moved to safer places at higher grounds. Some went to live with their relatives. About 1,100 *bigha* of agriculture land was inundated.
2003-2005	Flooding was recurrent. People used boats to commute when the village was inundated.

FIGURE 9 | Flood hazard map of Rampur Khadauna

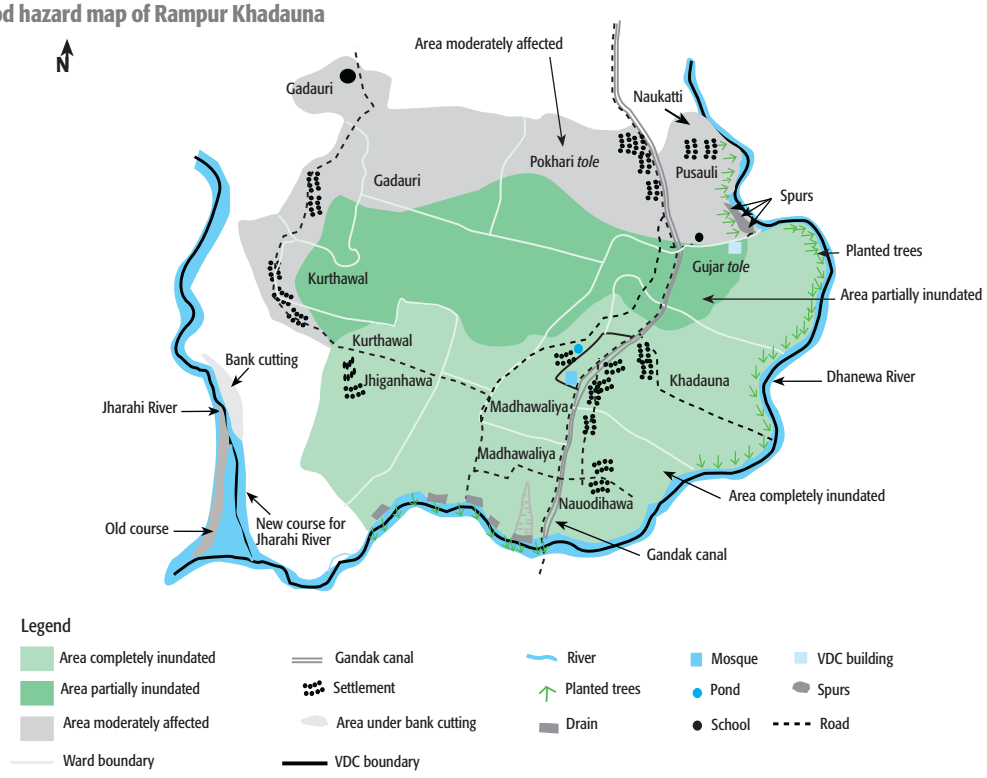


TABLE 12 | Ethno-History of Floods in Bhasedwa

Year	Event
1937	A September flood destroyed paddy before it was harvested. About 200 *bigha* of land was destroyed due to inundation and sand-casting. It damaged the paddy crop. However, the village was not damaged.
1965	Before paddy could be harvested floods buried more than 1,000 *bigha* of land under sand. The settlement was unharmed.
1970	Bank cutting washed away the forest of ward number 1. In other wards, sand deposition affected around 100 *bigha* of land. The land could not be made arable for long time.
1975	Sand deposition destroyed 200 *bigha* of land. Parts of forest and local pastures were also lost.
1978	Flood destroyed crops of 50 *bigha*. It also affected 50 households of Dholbaja *tole*. The population of ward number 5 was resettled by clearing forest near Hanumangad of the same ward. No effort was made to prevent bank cutting.
1985	Floods continue to destroy large tracts of land. The problem became recurrent after this year. Farmed land, pasture and orchards were lost. Between 1985 and 1991 around 100 *bigha* of land was lost due to bank cutting. No efforts were made to minimise the losses. In 1991 DDC and District Irrigation Office (DIO) supported construction of spurs made of bamboo piles. Sand bags were also placed. But the problem continued.
1993	An unprecedented flood occurred in the early hours (4:00 am) of 21 July. As it was time to start herding cattle to pastures some people were already awake. They warned the rest of the villagers providing much lead time for people to reach higher grounds. There was no loss of life. The entire village was under water. Bank cutting was rapid. 100 households belonging to ward number 6 (Chamar *Tole*) were displaced and went to live in a neighboring VDC. The poorer people took shelter at their relatives' homes. Some struggled to salvage their belongings by lighting petro-max at night. Sand deposition destroyed around 100 *bigha* of land. On August 10 another flood occurred. Its ferocity was lower than that of the July 21 flood but the flood led to widespread, rapid and devastating bank cutting. Within an hour, 262 feet of bank eroded.
1995-2003	Bank cutting was worse than in 1993. The flood of August 13, 1995 took 50 feet land. Floods of August 16, 17 and 18, 1997 led to bank cutting of 10 *bigha* of cultivated land. This flood washed away road linking the village to the north. The floods of July 21 and 25, 1998 displaced 25 households of Pokhara *tole*. Families moved at night. After the flood, more than 150 households have migrated and the trend continued until 2003. Everyone living in the *purano basti* of Bhasedwa migrated elsewhere.
2004	This flood was devastating compared to 1993 floods. The floods of 1993 had pushed an entire settlement to *naya basti*. The 2004 floods did not spare this basti - the settlement and surrounding fields were inundated. All *dalits* of ward number 2 and 3 were displaced. They started living in camps set up at Bhasedwa Primary school. The floods damaged the canal system of Bagmati Irrigation Project (BIP). A 250 meter long embankment and a spur built by BIP had not been complete as the construction began late. The embankment congested flow which became a serious hazard. The entire embankment including the spur was washed away. The soil used for building embankment and spur was spread over 100 *bigha* of land. Farmers still have not succeeded in recovering the land today.
2005	BIP constructed a 400 meter long embankment and a spur. This initiative has saved land behind the embankment. However, land areas both upstream and downstream of embankment face increased inundation and sediment deposition.

FIGURE 10 | Flood hazard map of Bhasedwa

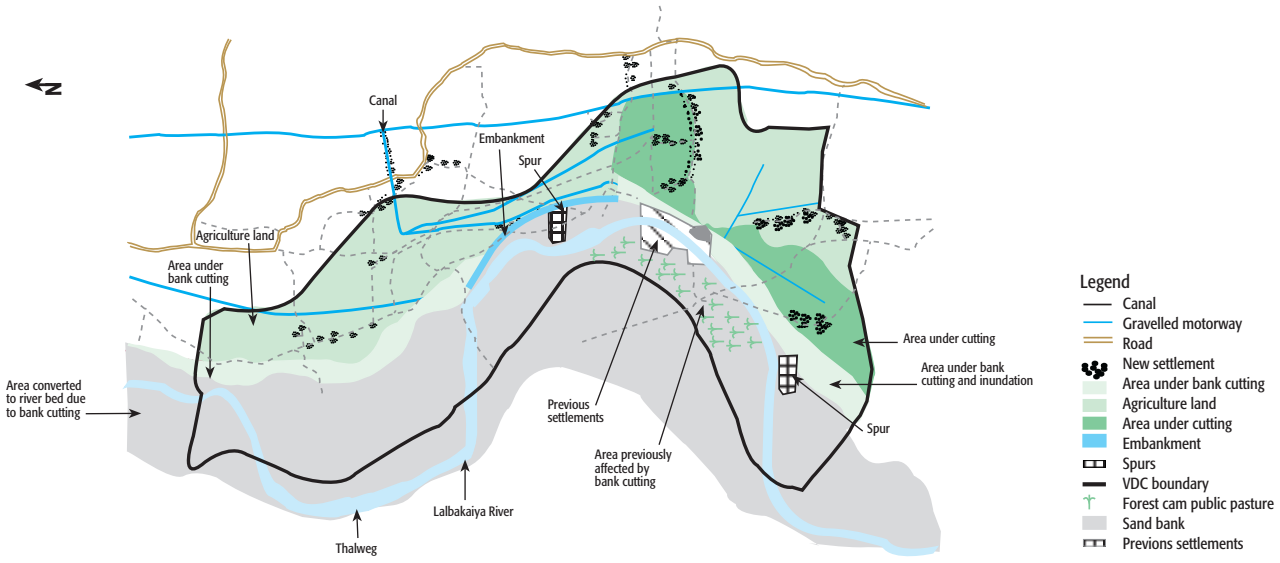
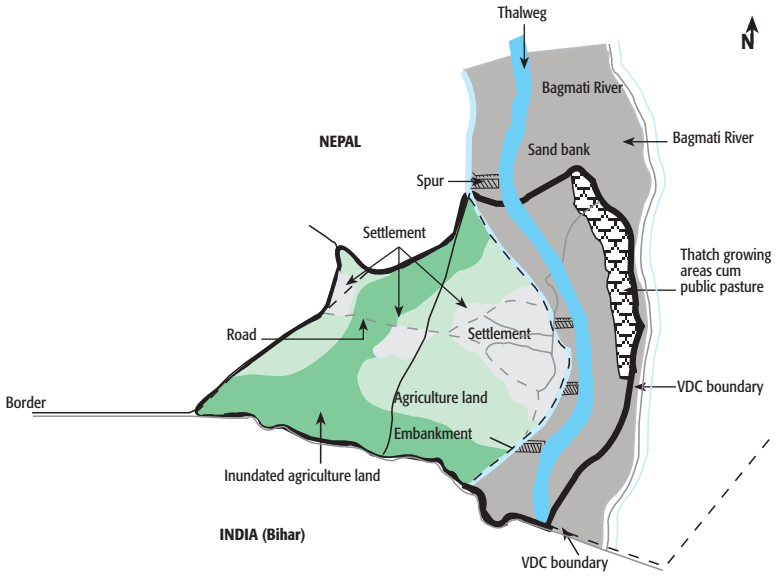


TABLE 13 | Ethno-History of Floods in Brahmapuri

Year	Event
1954	A major flood resulted in sediment deposition over the lands. Entire paddy crop was lost. Farm land looked like sand banks and could not be farmed for subsequent 7 years. During this period people faced food shortage. The river also brought tree trunks and deposited them in the fields. Some people collected the timber, sold them and made their living. People built resting places on stilts and lived on it for many days. Cooking was done on *machan.* Some families stacked one bed over the others to keep them dry. During the 7 year food shortage period, the richer households bought food from local and regional markets while the poor households migrated to India and neighbouring village in search of menial jobs. The remitance money they earned helped sustenance.
1960	Local initiatives to construct an irrigation system by damming Bagmati began. This was done to rejuvenate the land affected by sand deposition. The canal system irrigated 17 % of the land lying east of the village. The efforts to irrigate western areas resulted in the flooding of the village. In anguish people destroyed the dam and the initiative came to an end.
1961	Floods deposited silty-loam over areas affected by sand deposition in 1960 floods. Bagmati River flowed in two channels east and west of Brahmapuri. The westward channel accomodated the major flow while the eastward channel looked like a small irrigation canal. The westward channel of the river continuously impacted the Indian railway line in Bihar.
1966	The Indian Railway diverted flow of Bagmati from the western channel to eastern channel with the objective of protecting the railway lines. To that end wooden piles were driven and spurs were constructed in the western channel. Indian Railway provided compensation to farmers who owned land adjacent to the eastern channel. The farmers initially did not agree but later realised that river was gradually moving towards the eastern channel across the border. They agreed to be compensated.
1973	Bank cutting was a major problem after the river began flowing along the eastern channel.
1978	Nun toli of ward number 9 was displaced.
1993	Unprecedented flood occurs in the early morning (at 4:00 am) of July. In the village, the depth of flowing water was 5 feet. Villages as far as Barhathwa were inundated. The flood also washed an elephant. People could not move from the village in the dark because the entire village was inundated. People stacked beds, climbed roof, trees or to some raised place for safety. One boy was washed away. A woman lost both her sons along with her goats and oxen. Stored food became wet. People could not cook food even after the flood water receded. The houses were filled with muck for around 3-4 days. Relief agencies arrived only after the flood receded. People had to travel to Gaur to receive the relief materials because roads were damaged. Both rich and poor were equally affected as the stored grains had been damaged. Relief distribution was available continuously for three months which helped people to get back to their lives. All the households in ward number 8 were displaced. About 70 *bigha* of land was affected by sand deposit.
1998	Between 1998 and 2002, households of ward numbers 2, 6 and 7 continued to be displaced. The high school in Brahmapuri was washed away by the flood of 2002. The school did not reopen for almost one year.
2003	The lower section of Bagmati was embanked and spurs were constructed with assistance from the Government of India. This intervention has minimised bank cutting and flooding. However, Gaur municipality continued to be inundated.

FIGURE 11 | Flood hazard map of Brahmapuri



Vulnerability Assessment

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Inadequate drainage capacity results in failure of culverts.

One of the major focuses of the study was assessing the extent of vulnerability. The theoretical aspects of vulnerability are discussed in chapter 4 and were used to define the parameters in this assessment. Published literature, reports and documents were reviewed to select the parameters and several rounds of discussions were held with experts and knowledgeable persons. A checklist consisting of 25 parameters was prepared and discussed among the team members and the local communities. The components were as follows: a. physical, b. social, c. gender-related d. economic, e. access to communication, f. access to resources and g. psychological (Table 15). The parameters were weighted as shown in Table 14.

The tool thus developed was administered to all households in the four VDCs. Care was taken to ensure that households in each of the hazard sites identified above (See Figures 8,9,10 and 11) were included.

TABLE 14 | Vulnerability Ranking

Rank	Vulnerability type	Magnitude	For 25 parameters
V	Severe	4.1 – 5	101-125
IV	High	3.1 – 4	76-100
III	Moderate	2.1 – 3	51-75
II	Vulnerable	1.1 – 2	26-50
I	Low	1 and below	25 and below

TABLE 15 | Parameters of Vulnerability

	Parameters	Indicators
I	Physical	1 Frequency of flood
		2 Effects of flood
		3 Bank cutting/sand casting
		4 Damage to structures
		5 Effect of inundation – pollution
		6 Effect of inundation - on mobility
		7 House located along the banks
		8 House located next to embankments
		9 House located in the direction of flow
		10 Flood damaged - land types
II	Social	11 Access to education
		12 Head of household
		13 Mobility-less or no-mobility
III	Economic	14 Food sufficiency
		15 Land holding
		16 House types
		17 Source of income
		18 Food security
IV	Access to resources	19 Access to water, sanitation and health institutions
		20 Access to forests
		21 Access to service centres
V	Communication	22 Communication
VI	Gender Perspective	23 Group formation and funds collection
		24 Women participation in SHGs
VII	Psychological	25 Psychological

TABLE 16 | Aggregate and Ward Wise Vulnerability Assessment

Ward no.	Devgaun				Rampur Khadauna				Bhasedhawa				Brahmapuri			
	SV	HV	Rest	Total	SV	HV	Rest	Total	SV	HV	Rest	Total	SV	HV	Rest	Total
1	0	55	58	113	0	35	29	64	0	26	18	44	0	24	5	29
2	0	12	79	91	0	44	22	66	0	43	17	60	0	17	29	46
3	0	27	52	79	0	33	5	38	1	156	39	196	23	66	7	96
4	0	4	50	54	0	19	47	66	1	115	7	123	0	103	11	114
5	0	11	63	74	4	98	9	111	1	103	14	118	11	62	0	73
6	0	25	59	84	0	57	19	76	0	202	44	246	2	99	5	106
7	0	65	63	128	0	60	29	89	0	25	2	27	0	39	6	45
8	0	68	59	127	0	61	13	74	0	65	1	66	1	84	1	86
9	1	49	45	95	0	35	40	75	0	32	23	55	0	32	0	32
Total	1	316	528	845	4	442	213	659	3	767	165	935	37	526	64	627
Percentage	0	37	62.5	100	1	67	32	100	0.3	82	17.7	100	6	84	10	100

Notes: 45 Households of all 4 VDCs fall in severely vulnerable class (1.4 per cent), 2051 households of all 4 VDCs fall in highly vulnerable class (67.0 %), 970 households of all 4 VDCs fall in rest other classes (31.6 %). (The rest classes include moderately vulnerable, vulnerable and low vulnerable).

Nature of Vulnerability

Ward-wise results are presented in Table 16. These include households in the severely and highly vulnerable categories. Overall, 37%, 68%, 83% and 90 % of the populations in Devgaun, Rampur Khadauna, Bhasedhawa and Brahmapuri respectively are in the highly vulnerable category.

In all VDCs, poor access to information about policies, relief and climate issues emerged as the factors contributing most to vulnerability. There are no mechanisms for providing weather-related information or early warnings at the local level in any VDC. National radio and TVs do broadcast information on the daily temperatures and rainfall recorded at selected stations, but people rely on local indicators such as dark clouds to discern if it is likely to rain. The information on vulnerability collected was shared with the representatives of the VDCs and used to formulate pilot adaptive measures. Another factor was the gender imbalance.

TABLE 17 | VDC-Wise Vulnerability According to the Dis-aggregated Parameters

Component with magnitude of vulnerability	VDC wise households in different vulnerability class			
	Devgaun	Rampur Khadauna	Bhasedhawa	Brahmapuri
Physical				
Severe	-	57 (9)	16 (2)	65 (10)
High	100 (12)	376 (57)	637 (68)	336 (54)
Moderate to low	745 (88)	226 (34)	282 (30)	226 (36)
Total	845	659	935	627
Social				
Severe	9 (1)	3 (0.5)	4 (0.4)	5 (1)
High	180 (21)	101 (15)	158 (17)	104 (17)
Moderate to low	656 (78)	555 (84.5)	773(83)	518 (82)
Total	845	659	935	627
Economic				
Severe	207 (25)	220 (33)	447 (48)	482 (77)
High	291 (34)	233 (36)	341 (36)	87 (14)
Moderate to low	347 (41)	206 (31)	147 (16)	58 (9)
Total	845	659	935	627
Access to resources				
Severe	198 (23)	205 (31)	122 (13)	176 (28)
High	517 (61)	296 (45)	763 (82)	412 (66)
Moderate to low	130 (16)	158 (24)	50 (5)	39 (6)
Total	845	659	935	627
Access to communication				
Severe	474 (56)	423 (64)	599 (64)	375 (60)
High	6 (1)	1 (0)	-	-
Moderate to low	365 (43)	235 (36)	336 (36)	252(40)
Total	845	659	935	627
Gender perspective				
Severe	524 (62)	186 (28)	516 (55)	489 (78)
High	19 (2)	87 (13)	46 (5)	19 (3)
Moderate to low	302 (36)	386 (59)	373 (40)	119 (19)
Total	845	659	935	627
Psychological				
Severe	-	-	-	2 (0.3)
High	2 (0.3)	1 (0)	-	1 (0.2)
Moderate to low	843 (99.7)	658 (100)	935 (100)	624 (99.5)
Total	**845**	**659**	**935**	**627**

Shared Learning Dialogue (SLD)

SLD is a useful iterative tool of engagement.

A total of seven SLDs with flood-affected persons and key informants (KI) were carried out at each VDC. An attempt was made to include equal numbers of men and women in each SLD, but this was not always possible. To ensure that women were represented in SLDs, local partners were asked to visit villages and request women representatives to actively participate. The community suggested the timing and duration of the meetings. All proceedings were recorded so that the mix of Bhojpuri / Maithili and Nepali languages used in the discussion could be transcribed in Kathmandu and summaries prepared in English. Partnership with locally-based NGOs was helpful in conducting the SLDs.

A separate national-level SLD was also held. The discussions were recorded and summaries produced. Later SLDs in the VDCs were not recorded because the security situation in the Nepal Tarai deteriorated. The facilitators took notes during the discussions which were compiled to produce synopses. The findings from SLDs, hazard maps, vulnerability mapping and PRAs carried out at the ward level contributed to the conceptualisation of village-level adaptation action plans for all four VDCs. Past experiences from local organisations and other I / NGOs such as Oxfam GB, the Nepal Red Cross Society, and the Lutheran World Service were also referred to.

The major challenge during the SLDs was to estimate the extent of property lost due to floods in the past as people tended to exaggerate because they believed support agencies would not assist better off people. Organisations such as the Agricultural Department and the Poverty Alleviation Fund have conducted meetings and surveys in the past and some organisations even helped form groups, but people complained that there were no tangible benefits to the village and that work was limited mostly to collecting names and other information. People suspect that money is allocated by agencies but lost before it reaches the village level. The community repeatedly asked us what programmes would follow the SLDs and surveys.

Interacting with women was difficult even when women facilitated the discussions. This was especially so when they attempted to find out the difficulties faced by pregnant and menstruating women and new and lactating mothers during times of floods. Villagers were unwilling to reveal their experiences even to female community workers. The lack of toilets and the inability to commute were mentioned as major problems.

Bank-cutting is a major hazard as it does not spare even well-off landowners. Some landowners have lost all their assets in past floods. They lamented that their lineage would die out because no one would want to marry into their families.

Difficulties were encountered while carrying out SLDs. People wanted to know the political affiliation of the facilitators. They would ask, 'Which political party do you work for?' and complain that it is very hard to touch base with their political leaders. People also enquired about the benefits they would get from the study.

BOX 1 **National SLD**

A one-day national SLD on Flood Disaster Risk Reduction was organised in Kathmandu on 6 November, 2006 after several rounds of local-level SLDs were held. The objective was to discuss approaches that organisations in Nepal take in order to reduce flood disaster risk and to share perceptions from field. The meeting aimed to initiate discussions on the link between disaster risk mitigation and long-term development while sharing by sharing experiences. Representatives from organisations involved in water management and disaster prevention, NGOs, INGOs and the media participated in the SLD. The discussion focused on perceptions of hazard and organisational activities as well as on adaptation approaches to risk mitigation. Both climate-related and non-climate-induced disasters were discussed. Some of the key issues identified during the national SLD were as follows:

- Embankments have both positive and negative roles.
- Opportunities must be communicated to the local level, and awareness about disaster risk mitigation increased.
- The problems faced by rural residents do not get priority in the media.
- The National Disaster Mitigation Act of 1982 needs to be revised to incorporate preparedness, resettlement and rehabilitation aspects of disaster victims.
- Though awareness has increased people do not incorporate preventive measures such as retrofitting elements while building homes.
- Highway construction is a major cause of increased landslides.
- Communities need to be made aware of the adverse impact of roads and embankments.
- Financial measures such as insurance and micro credit are useful tool in disaster risk reduction.
- Disaster mitigation needs to be integrated into regular development programme such as water supply, sanitation and irrigation.
- Spillage of faeces from pit latrines is a hazard during flood.
- The lack comprehensive policy about issues of compensation, insurance and livelihood debilitates disaster risk reductions efforts.
- Communities seek compensation for properties lost due to flooding and submergence but laws are not very clear on this count.
- The red mark the Department of Water Induced Disaster Prevention (DWIDP) uses to delineate the extent of vulnerability on their maps drives land prices down. Many communities do not favour such a practice.

Local level share learning dialouge.

BOX 2 **Local SLDs**

The participants of local SLDs involved representatives of the four VDCs, Bramhapuri, Bhasedwa, Rampur Khadauna and Devgaon VDCs. During the SLDs participants discussed on flooding, the physical social characteristics of the region including changes in flow condition and impact of structures.

The Bagmati and the Lal Bakaiya River systems
Both rivers are sources of hazard in the monsoon. The rainfall in its hilly catchment is high and some pockets get cloudbursts. The result is immediate flooding. The 1993 flood was one such event. The lower region of Rautahat District is affected by embankments and other structures that constraint drainage causing prolonged inundation.

Though smaller than the Bagmati, the Lal Bakaiya is a flashy and turbulent river. Its head catchment is situated between the Chure and the Mahabharat ranges and the area receives high rainfall. The overland flow is collected and discharged through the narrow Chure gorge that travels with high velocity carrying sediment and debris load. This river causes bank cutting and much sand deposition.

The Rohini River system
The flooding of mainly the Jharahi and Dhanewa rivers affect Rampur Khadauna and Devgaon. Embankments and canals cause drainage congestion exacerbating the effects. The rising level of the river beds is another threat.

The following issues were identified

- Climate is changing due to the excessive use of natural resources, environmental degradation and human activities.
- There is no early warning system. People use their senses to feel the direction and movement of the air to predict possible rainfall and consequential flooding. A timely forecast could minimise the impact of flooding and help locals take preparedness activities.
- Flooding usually occurs at night when every one is asleep.
- Floods come even if it does not rain locally.
- Inundation lasts from a few hours to a few weeks depending upon the volume of rainfall.
- During floods, the members of the communities help each other without any discrimination based on religion, caste or political ideology.
- In all villages flooding affects women more than men.
- Embankments and check dams can minimise flood effects.
- In Bramhapuri the community use a local school building as a shelter during floods. In Rampur Khadauna, Oxfam GB has provided two boats to be used for rescue purpose.
- Bamboo and other trees on the river banks help minimise bank-cutting.
- Local communities have organised to form saving and credit groups in Bramhapuri, Rampur Khadauna and Devgaun.
- All of the villages have road system and access to communication such as CDMA. They listen to FM radio services.
- The government has made little effort to mitigate flood impacts in the villages. The communities seek support from government departments but do not know whom they should approach.
- None of the VDCs have government office, health post, sub-heath post, veterinary or agriculture service center. Villages have primary schools.
- Floods bring alluvial soil that improves agriculture and timber, which can be used as fuel.
- Flooding also destroys paddy, wheat and potatoes.
- *Masur*, *parwal*, watermelon, *aalas* and *aluwa* are planted on land covered with mix of sand and clay.
- The Nepal Gandak Canal passes through Rampur Khadauna and Devgaun but the supply of water for irrigation is unreliable.
- Groundwater table in Devgaun is between 60 and 70 meters deep and is difficult to tap for irrigation.
- Ram Gram, Butwal and Narayanghat in Nepal and the towns across the border in Uttar Pradesh are potential markets for the agriculture produce of Rampur Khadauna and Devgaun. Chandranigahapur and Gaur in Nepal and Baraganiya in Bihar are potential markets for farmers of Brahmapuri and Bhasedwa.
- Embankments built along the banks of the Bagmati, Lalbakaiya, Jharahi, Dhanewa and Bhalui rivers occasionally breach. Bank-cutting is common.
- The poor and so-called low-caste families are most seriously affected by floods.
- Agricultural production is decreasing and poverty increasing. The poor get displaced each year and become landless.
- In the aftermath of floods epidemics are common. There is no organised response to alleviate the spread of diseases. Mechanism to provide medical support is very poor.
- Groundwater contamination due to arsenic is high in both Rauthaut and Nawalparasi districts. People need to be provided with support to mitigate biological and arsenic contamination of water.
- Flat roofs on the houses would help save household assets.
- Young males migrate to cities in India, Kathmandu and abroad seeking employment. They send remittances home.
- The government of Nepal does not subsidise fertilisers for farmers, who rely on Indian markets for their purchase. This causes huge difference of the produce.

Adaptation Strategies Identified

In the course of the SLDs the following measures to support adaptation were identified:

- Establishment of a simple early warning system to communicate and forecast the weather and flood dated information.
- Providing information about rainfall is important because it triggers all floods.
- Enhancing understanding concerning the influence of human interventions on flooding.
- Improving the existing canal to enhance the reliability of irrigation.
- Making arrangement for boats to evacuate villagers.
- Providing support to improve homes and evacuation shelters.
- Introducing appropriate measures to make use of groundwater in income-generating activities.
- Retaining and stabilising rivers banks.
- Insuring livestock and grains.
- Training and building the capacity of local communities.
- Providing of sanitation and drinking water facilities during floods.
- Supporting self-help-groups (SHG)
- Providing skill training for pursuing alternative livelihoods.
- Establishing fodder banks for livestock.
- Providing access to improved seeds for agriculture.
- Improving access to fertilisers and other inputs.
- Preparing VDC-level plan for adaptation.
- Improving drainage.
- Using flood-damaged river banks and flood plains for economic benefit.
- Mitigation of arsenic and bacteriological contamination in drinking water.
- Conducting community forestry activities.
- Establishing information centres.

Using visual and audio recording to capture nuances of the dialogues was useful though it required the study team to put in additional time, resources and commitment. Others researchers and facilitators need to be made aware of the value of recording, but caution is necessary while recording in conflict environments. Indeed, in all cases, the prior approval of the community has to be sought.

Since the CVA method used is static, it is difficult to capture dynamic vulnerability. Furthermore, major questions exist regarding how CVA can be incorporated into operational disaster risk reduction programmes. One way could be to provide a picture of the changing context of vulnerability by conducting CVAs at different times before and following floods. The study team intends to use this approach after the monsoon season of 2007. We hope it will help capture differences and thereby provide a basis for assessing the relevance and feasibility of the method.

Continuing dialogue with a community through SLDs is clearly a useful approach. It provides a realistic understanding of the concerns of the community and helps design support measures which build local capacity for adaptation. In other words, it can help those affected by flood disaster to identify effective responses, save assets, avoid diseases, and rebuild livelihoods. Many development programmes have aimed to achieve such outcomes but are hamstrung because they focus on the conventional top-down methods. Locating a bottom-up programme like ours within the larger framework, in contrast, can help begin the process of engaging with the root causes of vulnerability while devising practical measures to respond to the immediate needs of achieving improved security from flooding.

Conclusions

A more logical response to mitigating flood disasters is to ensure unhindered drainage.

This study has provided a broad overview of the impact of flood disasters on four VDCs situated in the Nepal Tarai along two trans-boundary rivers. The VDCs are located in the south of Nepal contiguous to the plains of Uttar Pradesh and Bihar and are typical of many communities living in the Nepal Tarai.

The study has shown that sustained monsoon rains and cloudbursts in river catchments are the main trigger of flooding in Nepal. In many cases, infrastructure constructed to improve living conditions and provide security against floods has, however, actually added to the misery of VDC residents by slowing drainage and increasing the extent of inundation. The impact of flooding is an outcome of both social and economic factors as well as political and historical processes. Gender inequity further accentuates vulnerability. Although we did examine this aspect in detail, the ongoing turmoil and violence in the Nepal Tarai is an additional debilitating factor. Very little real-time information is available about any given flood situation as the mobility of the people is limited due to inundated roads, frequent road blocks due to *bandh* (political action of closing roads) and poor security. The remoteness of the area adds to the problem. It is likely that stories of human misery will abound in the study villages and elsewhere after the 2007 monsoon rains receded and the affected regions are more accessible.

We can argue that flood disaster risk reduction needs to undergo a paradigm shift if it is to find salience in the changing social and physical context. For mitigating flood damage, structural or engineering approaches, despite their limitations, continue to get preference over softer methods. The concerns of affected individuals, families and communities have not been systematically woven into this approach to policy making. Governmental policies have not helped build resilience to floods or the ability to cope with their effects. Institutional dysfunction is widespread: state agencies fail to innovate and make their responses to flood disasters effective. Poor drainage and waterlogging are widespread and their impact on communities is serious.

The primary reason for flooding is high rainfall during the monsoon combined with interventions that block drainage. While the rainfall sustains region's agriculture, when the land becomes totally saturated, excess overland flooding that river channels cannot accommodate spills onto the land adjoining river banks causing prolonged inundation, loss of crops and land, and other damage. A logical response to mitigating flood disasters is to ensure that there is unhindered drainage of floodwater into rivers and to reduce vulnerability. Hydro-meteorology, disasters as opportunities and adaptive responses are issues worth highlighting.

Hydro-meteorology

Achieving effective disaster risk reduction requires developing a better understanding of the study region's hydro-meteorological character. The collection, collation and dissemination of data on rainfall, river flow, sediment-load

and geomorphology are essential. To capture the variability exhibited by micro-climates, we need more stations to monitor rainfall and other climatic parameters in the Tarai and mountainous regions. The data from such stations can help improve our understanding of the climatic conditions of the region. They will also be useful for forecasting and thus enabling preparedness for minimising flooding provided that the data they collect can be disseminated, interpreted and analysed in time. Particularly in fields such as disaster mitigation where responses depend on a combination of basic scientific and wide social factors, it is critical that society has the capacity to analyse data and identify their needs and alternatives.

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Stream unable to flow through existing culvert is flowing along Nepal's east-west highway in Bardiya.

Disasters as Opportunities

Though they are part and parcel of the region, flood hazards have disruptive effects on societies and communities. One flood disaster makes the poor more vulnerable to the next and, in consequence, converts a single disaster into a series of disasters. Flood hazards become social disasters as victims are created by economic and social differences. Yet, disaster can be used as an avenue to create new mechanisms to enable vulnerable groups and those repeatedly affected by hazards to reduce their vulnerability. To that end, strategies should be formulated in such a way that they strive to change the pattern of relationships and institutional arrangements that exacerbate vulnerability to floods or any other natural hazard.

A disaster can also be used as an opportunity by planners and scientists to understand the processes within a particular geographical area, where interaction among natural, economic, social, and developmental activities result in a particular level of impact during flood events. Such an understanding would help those concerned identify new avenues for action. Though such window of opportunity may not always catalyse change or provide incentive for putting in place a more proactive approach to disaster risk, they do lay bare the inner weakness of a society, which can be used as a forensic opportunity to examine the existing interrelationship. Their usefulness to policy process may not be direct but cannot be underestimated.

The links between livelihood strategies and the environment are exposed in the aftermath of a disaster.

One area to focus on is on understanding how livelihoods are affected, readjusted or rebuilt in a post-disaster situation. Changes in patterns and strategies adopted for making a livelihood need to be examined. The links between livelihood strategies and the environment are exposed in the aftermath of a disaster. Mitigation strategies must suit social and ecological environments and help build livelihoods. The majority of the affected people in the four VDCs studied are

disadvantaged by their location and their actual hardships often go unheard when mitigation strategies are planned. By ensuring that space is created for their voices to be heard, their relative isolation can be ended. The hardships of those hit by a disaster and the support they see as necessary should be the prime concern when mitigation strategies are formulated.

Another aspect of disaster risk reduction involves analysing the driving forces that have framed national policy regarding disaster mitigation and how that policy has changed over time. Questions regarding how policy translates into procedures in the field and how it matches (or does not match) the requirements of the affected people require much deeper analysis. The answers to these questions can be useful in the execution of institutional innovations.

How policy translates into procedures in the field is important.

Adaptive Approach

Practical methods for minimising the negative social impacts of floods can often be found by building on the actions that families already take and by designing interventions which can accommodate changing situations. Such interventions need to address the challenges that a flood hazard poses as well as its impacts. In the case of floods, for example, local people often seek safety from rising floodwater by moving to higher ground, planting flood-resistant or early ripening variety crops, and stockpiling some food and emergency supplies including basic medicines, though such examples are very few. Poor access to basic drinking water, sanitation, basic health services and food stuff, however, continue be a major problem for the millions marooned. It is clear that these services must be made available, but the how question remains unanswered. We need

to continue institutional innovations to help improve access to safe drinking water during floods.

Strategies that assist people in developing alternative and less vulnerable livelihoods and reducing their susceptibility to flood hazards may be a more effective response than focusing exclusively on structural measures to control floods. An appropriate strategy might be, as people have traditionally done, to build houses on stilts or on high points ('islands') for respite during flooding. Such an approach would allow flood water to drain quickly and thus remain standing for a shorter period; it also would not interfere with the beneficial deposition of fertile silt on agricultural land. Community forestry activities can help promoting biological shield as buffer zones along the flood plains.

A control-focused approach based on embankment building, in contrast, separates rivers from their flood plains and nullifies the benefit of flood spreading. Overall, approaches that attempt to reduce the vulnerability of people to flood hazards by enhancing capacity and by building on existing mitigation actions may be more effective. An added local benefit is that people can implement these measures in their localities without major institutional restructuring. Some strategies are already being employed while others were identified in course of the study.

In the long term, building transport and informational infrastructures that do not impede drainage may prove to be effective in mitigating flood disasters. It is worth repeating that roads must be designed so they do not hinder drainage. Managing drainage is a challenge for the community of civil engineers in South Asia; national engineering codes will need revision and new insights incorporated in water education stream. We need to focus on the formulation and implementation of appropriate laws and on compliance with municipal codes. This is an arena for continued thinking and investigation. Improving preventive health care facilities and diversifying livelihoods are other challenges. These are elements of governance which need to evolve in any given geographical, social and political context.

In the End

Flood hazards are widespread and have different negative impacts on different communities and households. During the monsoon in South Asia large-scale inundation causes hardship to people in the plains, while landslides, mud and debris flow affect people the hills. Governments of South Asian nations need to focus on approaches that are rooted in the nature of the problems, whether rural or urban areas. People in

Improving preventive health care facilities and educational institutions and diversifying livelihoods can build adaptive capacity.

Roads and transportation help mobility but poorly designed bridges can constrain drainage and exacerbate flooding.

rural areas face disadvantages stemming from the lack of educational and basic heath services, job insecurity, poorly diversified livelihoods, underemployment and unemployment. In addition, prevailing policies often discriminate against women and deny economically and socially disadvantaged communities access and entitlement to assets. The market tends to take advantage of people rather than the other way around; marginalised farmers often cannot negotiate good bargains. An effective response to flood disaster mitigation calls for the creation of pro-poor policy regimes and the allocation of resources to vulnerable groups. The devolution of political power can make measures for minimising the impacts of flooding more effective.

The government must facilitate the creation of a level playing field for unbiased regulation, monitoring and facilitation.

The government must facilitate the creation of a level playing field through unbiased regulation, monitoring and facilitation. In its turn, the market must innovate in order to create asset-building opportunities. Uncontested, both the government and market show tendencies towards centralisation and rapaciousness. Egalitarian social auditors, using critical rationality, must provide a balance. When all three social solidarities are balanced, the terrain will be in a creative tension, thereby making an effective response to flood disaster mitigation possible.

In the plains of the Himalaya-Ganga human settlement has evolved adapting to flood and low flow conditions in rivers. The notion of totally controlling flooding is neither possible nor desirable. Flood damage mitigation approaches need to begin by ensuring drainage and minimising flood risks at local levels. This reorientation needs to be supported by a framework of governance which focuses on empowering communities to build their assets and resilience. Such initiatives need to be part of a societal process in which there is space for a regulatory hierarchic state, an innovative individualistic market and cautionary social auditors to remain in a creative balance.

The implementation of this study coincided with one of the most difficult and tumultuous period in Nepal history, as the country moves towards social and political restructuring. As expected, regional groups and other interests are being expressed but have yet to be resolved through political negotiations. Also Nepal's Tarai region is in a state of turmoil. One manifestation of the confusion has been violence. In fact, Rautahat District saw one of worst examples of carnage in Nepal's history as thirty persons were killed in a single event of political violence. Despite the sense of insecurity, the presence of locally-based groups enabled the study to go ahead.

Needless to say the capacity to respond to the impacts of change, including those induced by climate change, is essential. Referring to the Himalayan region, the fourth IPCC (2007) report has suggested that "heavy precipitation events, which are very likely to increase in frequency, will augment flood risk." The communities in the lower Bagmati and Rohini regions face such a risk. This study has enabled us to better understand the nature of vulnerability of the communities to such a risk and how their ability to adapt could be enhanced and the risks minimised as Nepal and Nepali societies continue to undergo transformative change. The exact way in which this understanding will contribute to policy-making is an issue for the future.

Bibliography

Ahmed I. (1999) Living with Floods: An Exercise in Alternative, The University Press Limited, Dhaka.

Bandhyopadhya, J. (1999) Need for a realistic view, *Seminar* pp. 52-61.

BDPF, Duryog Nivaran and BUET (1995) May 4-6 Regional Cooperation in Flood Warning; Report of the Workshop organized by Bangladesh Disaster Preparedness Forum (BDPF), Duryog Nivaran and Department of Water Resources Engineering of the Bangladesh University of Engineering and Technology (BUET); Dhaka.

DPTC (1993) Annual Disaster Review, Water Induced Disaster Prevention Technical Centre, Lalitpur, Nepal.

DWIDP (2005) Final Report on preparation of Water-Induced Hazard Maps of The Bagmati River Basin, December, Kathmandu.

Gyawali, D. and Dixit, A. (1994) The Himalaya Ganga: Contending with Inter-linkages in a Complex System: *Water Nepal*, 4(1): 1-6.

Hagen, T. (1998) *Nepal the Kingdom in the Himalaya*, Himal Books, Lalitpur Nepal.

Intergovernmental Panel on Climate Change, Working Group 2 (2007), *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability, Summary for Policy Makers*.

MoWR (1993*) Report on Floods in Bagmati River Basin July 19-21, 1993*, Ministry of Water Resources, Government of Nepal, Kathmandu.

Moench, M. and Dixit, A. (eds.) (2004) *Adaptive Capacity and Livelihood Resilience*, Adaptive Strategies for Responding to Floods and Droughts in South Asia, June, The Institute for Social and Environmental Transition, International, Boulder, Colorado, USA and the Institute for Social and Environmental Transition, Nepal.

Nishat, A., Reazauddin M., Amin, R., and Khan, A. R. (eds.) (2000) The 1998 floods Impact on Environment, Department of Environment and IUCN Bangladesh, Dhaka x+269 pages

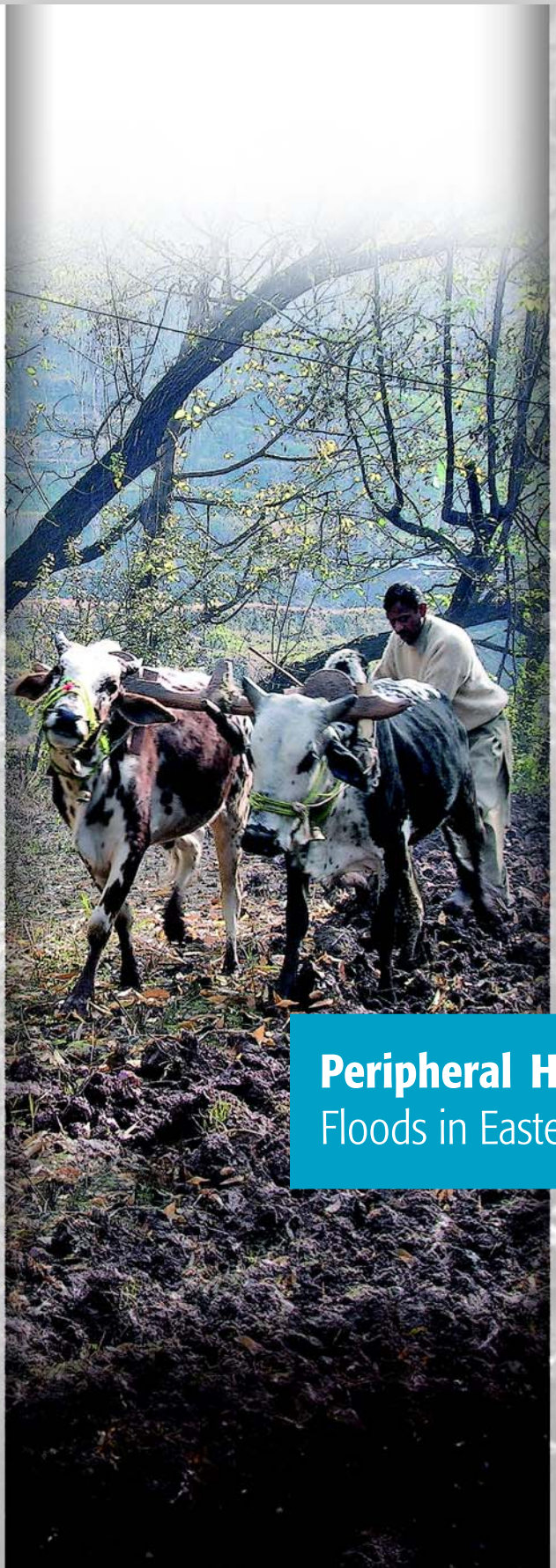
People's Commission (1998) The Troubled Waters: A Report on the 1998 floods in Eastern Uttar Pradesh Independent People's Commission on Floods in UP.

Poudel S. N., Pandit, R. K., and Roshan S. (2002) Community approach to flood management in Nepal, A Pilot Case Study, Jal Shrot Vikas Sanstha, Kathmandu.

Sharma C.K. (1977) River System of Nepal, published by Mrs. Sangeeta Sharma 23/281 Bishalnagar, Kathmandu Nepal.

Shanker, K. (1985) Water Resources, In T.C. Majupuria (ed), Nepal: Nature's Paradise pp 25-31. White Lotus Co., Bangkok.

Upreti, B. N. and Dhital, M. R. (1995) July *Landslide Studies and Management in Nepal Himalaya*; paper submitted to the International Center for Integrated Mountain Development (ICIMOD), Kathmandu.



CHAPTER 7

Peripheral Heartland: Floods in Eastern Uttar Pradesh

Shashikant Chopde, Shiraz A. Wajih and Amit Kumar

Case Study Guidance Note

Country: India
Location: Uttar Pradesh
Date: May 2007
Sector and Spatial focus: Adaptation and DRR
Title: Peripheral Heartland: Floods in Eastern Uttar Pradesh
Bibliographical reference: Chopde *et al.* (2007) Peripheral Heartland: Floods in Eastern Uttar Pradesh

Abstract

The challenge of climate variability and change are increasingly recognised as serious impediments to poverty alleviation. Floods, for example, reverse the development process to a great extent and worsen the situation of disadvantaged and vulnerable groups. The post-disaster context, especially, offers a window of opportunity for political support and for development processes. There is a need to make best use of this opportunity to bring in a change, to design and implement systems in a way that mitigates disaster risk for future risks. The strategy followed is to work outward from the conditions of a household or community and those factors enabling or constraining responses to disasters to identify points of leverage for change. Shared learning dialogues (SLDs) are central to this process because they allow us and the community to build a shared understanding of opportunities and constraints without being held in by predefined notions of what risk reduction consists of.

Eastern UP is a flood prone region of the Indo-Gangetic plain of India. The methodology for the project involves vulnerability and capacity analysis and SLDs. Information from previous studies is being used. The research is finding that a significant number of households are more vulnerable due to factors related to the during-flood and post-flood periods than to physical damage caused by floods. Key factors causing vulnerability in a community are the lack of diversified agriculture systems and income avenues that are less susceptible to the impacts of floods. The most vulnerable group, however, are the landless who are significantly dependent on agriculture labor for their income.

The SLDs were helpful in identifying strategies that included sets of direct risk reduction interventions and interventions for changing underlying systems for adaptation.

Capacity and vulnerability analyses (CVAs) in conjunction with SLDs at different levels can help identify solutions envisaged in DRR. The ongoing research is showing that both CVAs and SLDs generate multi-pronged benefits in terms of data collection, validation and triangulation of the data, stakeholder engagement and policy advocacy. Most importantly, they also help identify potential solutions and mechanisms for development interventions.

Technical Description

- Hazard / risk type: Floods - recurrent and frequent disruption of human and livelihood systems.
- Type of assessment: Research to understand the factors that constrain and enable local communities to reduce risk and adapt to climatic and other sources of vulnerability

Research and Analytical Process

- Methods / tools used: Scoping surveys, SLDs, ranking tools

Key Insights Generated for Vulnerability Reduction and Capacity Enhancement

- Direct support to DRR and Adaptation: Agriculture interventions relating to inundation resistant and early sowing / harvesting crops, irrigation technologies enhancing access to irrigation, financial risk spreading through crop insurance, innovative models of sanitation and handpumps, housing technology resistant to floods, and early warning systems.
- System Level support: Adaptation incubation systems that support self-management of people's institutions for continual innovations in agriculture and communication, and improvement in education, health and transport systems.

Potential Strategies Identified:

See Table on following page.

Strategic Notes and Lessons Learned – Key Points to Emphasise:

- Capacity and vulnerability analyses act as an initial pointer to the solutions envisaged in disaster risk reduction, complemented by the SLDs at different levels. This study establishes that both these tools / techniques do work and that they generate multi-pronged benefits in terms of data, validation and triangulation of data collected, stakeholder engagement and policy advocacy. Most importantly, they also help to identify potential solutions and mechanisms for development interventions.
- At the field level, SLDs conducted with disaster affected communities not only serve as a platform for sharing experience but also help to identify useful solutions for problems identified by the community.
- SLDs are useful in building capacity in community members and the project team.
- SLDs are a two-way knowledge transfer process. For example, we communicate technical and qualitative details of global warming to local communities. Community members, in return, explain to us the impacts at the field level (both existing and expected) in terms of occupational mobility, migration patterns, livelihood systems etc.
- This two-way transfer of information regarding knowledge of climate change and its impacts (tangible or indirect) needs to be interposed with the community's perspectives. These set the stage for making decisions on key action points.
- Solutions emerging in SLDs need to be documented and shared with stakeholders during further SLDs and / or in meetings with policy makers.
- SLDs need to be have greater participation from women and other marginalized groups.

Village	Description	ADAPTATION SPECIFIC INTERVENTIONS				
		Diversification	Ecosystem	Disaster Risk Reduction	Organization & Incubation	Skill Development
Lakshmipur	Population-1,765 (M-726, F-679, C-360), Agricultural land-125 hectares: irrigated-95, non-irrigated-30, Total HH-199, most people (80%) are small farmers	Early maturing and water-standing crops, fodder conservation	Increasing soil fertility through soil testing and treatment , Checking soil erosion through bamboo cultivation on the land between embankment and river, making water logging area cultivable	Provision of irrigation pumps, maintaining and disinfecting hand pumps, construction of drainage pipes but depending upon support of local people (on both sides embankment and road)	Self-managing institutions, formation of farmers groups, village health committee, establishing village resource centres and self-help groups	Awareness programme & training: intensive farming, design and construction of portable raised toilets, personal hygiene
Sonatikar	Population-525 (M-242, F-198, C-85), Agricultural land-78 hectares: irrigated-68, non-irrigated-10, Total HH-100	Early maturing paddy crop, water-standing crop, mixed cropping, increase cropping intensity,vegetable production	Increasing soil fertility through soil testing and treatment, Utilising water bodies for Fisheries	Provision of community tubewells, maintaining hand pumps	Self-managing institutions, formation of farmers groups, establishing village resource centres and self-help groups	Awareness programme on disaster mitigation & training: intensive farming, vegetable production, seed production, water-standing crops, composting, personal hygiene
Manoharchak	Population-467 (M-198, F-186, C-83), Agricultural land-45 hectares: irrigated-29, non-irrigated-16, Total HH-104	Early maturing and water-standing crops, fodder conservation	Increasing soil fertility through soil testing and treatment , Checking soil erosion through bamboo cultivation on the land between embankment and river	Provision of community tubewells, maintaining hand pumps, training in making raised hygienic toilets, immunisation of children and livestock	Self-managing institutions, formation of farmers groups, establishing village resource centres and self-help groups and health committees	Awareness programmes on disaster mitigation, training and exposure visits

M = Males F = Females C = Children HH = Households

- SLDs act as a triangulation and validation tool.
- System and process delivery needs, including those related to policies, should be identified at all levels. The overall SLD process can be viewed as a pyramidal set-up primarily for increasing the number of "solutions" identified and promoted through dialogue across all levels.

Keywords: Floods, SLD, CVA, Climate Change, Adaptation, DRR ,Uttar Pradesh

Resource persons: Shashikant Chopde and Shiraz Wajih

	UNDERLYING SYSTEM FOR ADAPTATION						
	Financial and Risk Spreading	**Communication**	**Education**	**Transport**	**Financial Mechanism**	**Organisation**	**Livelihood**
	Income generation activities such as mushroom production, goat rearing, fisheries, poultry farming, candle-making	Information centre at village level, early warning systems, communication centres, community radio (FM), mobile phones	Training on seed production, Kishan Credit Cards-KCC-(farmer's credit cards), crop insurance,ensuring availability of Information, Education and Communication (IEC) materials, exposure visits	Boats, bamboo bridge	Linking self-help groups with banks and savings and credit organisations	Community irrigation management, setting up systems for community contributions to repair water pumps	Off-season vegetable & mushroom farming, seed production, kitchen gardening and vermicomposting
	Income generation activities such as mushroom production, goat rearing, fisheries, poultry farming, candle-making	Information centre at village level, early warning systems, communication centres, community radio (FM), mobile phones	Training on seed production,vermi and nadep composting,ensuring avability of IEC materials, exposure visits, KCC and crop insurance	Boats, bamboo bridge	Linking self-help groups with banks and savings and credit organisations	Community irrigation management	Off-season vegetable & mushroom farming, seed production, kitchen gardening and vermicomposting
	Income generation activities such as mushroom production, kitchen gardening, goat rearing, fisheries, poultry farming, candle-making	Information centre at village level, developing and early warning system through mobile phones and community radio (FM) but depending upon external stakeholder's support	Training on KCC, crop insurance, ensuring avability of IEC materials through resource centre, exposure visits	Boats, bamboo bridge	Linking self-help groups with banks and savings and credit organisations	Community irrigation management, voluntarily draining excess water	vegetable and mushroom production, seed production, kitchen gardening, vnursery raising , vermicomposting, goat rearing, fisheries, incense stick-making, candle-making

Introduction

Mechanisms can be identified by working with households, communities and other local entities to identify the factors that constrain or enable them to respond to events that could cause disaster.

The impacts of climate variability and change are increasingly being recognised as serious impediments to poverty alleviation in South Asia. In fact, the repeated occurrence of disasters such as floods and droughts and their impacts has added a new layer to the endemic poverty of a large section of the Indian populace. Extreme events worsen the situation of disadvantaged and vulnerable groups and reverse the few benefits which have accrued from the development process. South Asia's seventy per cent of disasters are climate related and as global climatic change increases the frequency and intensity of floods and drought events, the poor and the disadvantaged will become even more vulnerable. Furthermore, much of the world's population lives in vulnerable regions and the number of such people is projected to grow. Unless the cycle of disaster and poverty can be broken, the world stands little chance of ever reaching the millennium development goals (MDGs).

It is worthwhile to note that there is a silver lining under the dark cloud of disasters. This lining is the window of opportunity the disasters create not only for influencing the approaches of development practitioners and policy-makers but also for catalysing political support for change in post-disaster contexts. Disasters create an opportunity as affected local populations tend to be more willing to make structural and livelihood changes they might otherwise not have been willing to make. Further, the financial constraints faced by poor and vulnerable communities can be overcome more easily in post-disaster contexts, when a flow of funds is made available through government grants, relief aid and other support. Though such opportunities are pulsed, they promote a better understanding of disaster recovery processes and enable the introduction of measures for systemic changes. Often, the impact of extreme climatic events intertwine with the social and economic constraints prevailing within a region - such as a non-diversified livelihood base and poor social and economic infrastructures – and make its population more vulnerable.

During the course of this study, we did not limit our definition of interventions for disaster risk reduction to conventional techniques such as structural protection and provision of relief. We believe that other practical and effective mechanisms can be identified by working with households, communities and other local entities to identify those factors that constrain or enable them to respond to events that could cause disaster. In almost all communities, some groups are relatively unaffected by extreme events while others are devastated. The differences between those who thrive despite the impacts of extreme events and those who are harmed reveal the nature of both enabling and constraining factors and include behavioural as well as other factors. The identification of differences can, in turn, help identify points of leverage (policy, infrastructure or other changes) for removing constraints which limit the ability of vulnerable groups to

undertake the actions to reduce vulnerability that unaffected groups generally take. Once these constraints are known we can identify strategies that should help local people respond better to local conditions.

Our overall strategy is to work outward from the conditions of a household or a community. Shared learning dialogues (SLDs) are central because they allow us researchers, to build a shared understanding of opportunities and constraints without being limited by pre-conceived notions of what risk reduction constitutes. Through dialogue and semi-structured qualitative and quantitative surveys with local communities, government representatives, NGOs and other actors in the area, our goal is to develop both a shared vision of key issues and a semi-quantitative baseline of information.

The impacts of monsoon river floods, which occur more regularly than coastal floods are well documented and understood, the mitigation strategies adopted by state agencies are fairly well reported on. The strategies local communities pursue for coping with and adapting to such impacts, in contrast, are not at all well documented. This paper discusses the strategies adopted by communities within the flood-affected region of the Rohini Basin in India's Eastern Uttar Pradesh, India. The case study field sites were selected because the issues that are most important at the field level – access to communication systems and the location of homes in vulnerable areas such a flood plains – relate well to national policy regarding, knowledge management in the areas of environmental management, vulnerability and communication.

These field locations are also vulnerable to the sudden problems, typically associated with flooding or extreme storm events. As a result, issues related to early warning systems and the role of ecosystems in buffering floods and storms are significant. In addition, the rapid onset of floods and the vulnerable locations of homes and workplaces at the field sites resemble patterns of vulnerability similar to those of other field sites for this project in India, Nepal and Pakistan. In fact, the field-level scenario as well as the national-level policy and knowledge management activities found in the Eastern Utter Pradesh study are both core parts of a larger programme on adaptation as well as being an integrated study of their own.

The strategies local communities pursue for coping with and adapting to flood impacts are not at all well documented.

Two villages in Maharajganj District, Lakshmipur and Manoharchak, and one village in Gorakhpur District, Sonatikar were selected in Eastern Uttar Pradesh. In all three villages, flood disaster is a process rather than a single event. Each disaster makes the poor more vulnerable to the next disaster and all disasters are a normal condition for those repeatedly affected. This process is aggravated by the fact that these communities suffer from multiple hazards, both natural and man-made.

Peripheral Heartland

Around 29 % of the 33,270 km^2 of Eastern Uttar Pradesh is a flood-prone region of the Indo-Gangetic plain. The flood-affected areas cover the low lying districts of Gorakhpur and Maharajganj, whose socio-economic and human development indices are lower than those of other Indian states (Figure 1). Floods affect agriculture, the main source of livelihood in this region, disrupt life

and devastate property on a large scale, impede socio-economic progress, including education, and destroy rural infrastructure. The effects of flooding are exacerbated by the characteristics which prevail in the region: poverty, poor health services, malnutrition, illiteracy, lack of food and livelihood security, extensive out-migration and ecological degradation.

Eastern Uttar Pradesh constitutes a riparian land system formed by the Gandak, West Rapti rivers and the Rohini River system. Situated north of the Ganga River, the region is commonly known as the trans-Saryu plain. The Gandak is a snow-fed river that originates in Nepal. The West Rapti also originates in Nepal, flowing down from the Mahabharat range, and meeting the Gandak near the town of Gorakhpur, Eastern Uttar Pradesh. The Rohini River system, which originates in Nepal, is composed of three rivers, the Rohini, the Tinau and the Banagana and their tributaries. Weirs and barrages have been built on the Gandak and the West Rapti rivers as well as on some of their tributaries. Although the Rohini River system is used extensively and causes large-scale flood damage, it does not appear on the radar screen of the government of either Nepal or India.

The average annual rainfall in the area is between 800 mm and 900 mm. The maximum rainfall generally occurs in July and the minimum, which is negligible, occurs between December and March.

Field sites for this case study were selected within the Rohini Basin because it has faced major floods in the past: In 1904, each year between 1952 and 1957, in 1960, and their again in1962, 1968, 1970, 1971, 1974, 1980, 1981, 1995, 1996, 1998, 2000 and 2001. The 2001 flood was followed by a drought in 2002. Attempts have been made to control flooding along the Rohini by constructing embankments, a process which began in 1952 and continued intermittently until 1985. Every flood led to the loss of crops, dwellings, food grains, seeds and personal belongings, and each case villagers sought shelter on nearby embankments for many days. The receding floodwaters deposited sand on agricultural land, rendering the land unproductive. With the exception of the 1998 flood, which was the result of a very wet monsoon mostly in the Rohini River system, every flood event here was the result of rivers in the lower parts of the north Ganga plains overflowing.

FIGURE 1 | Gorakhpur/Maharajganj

The Study Villages

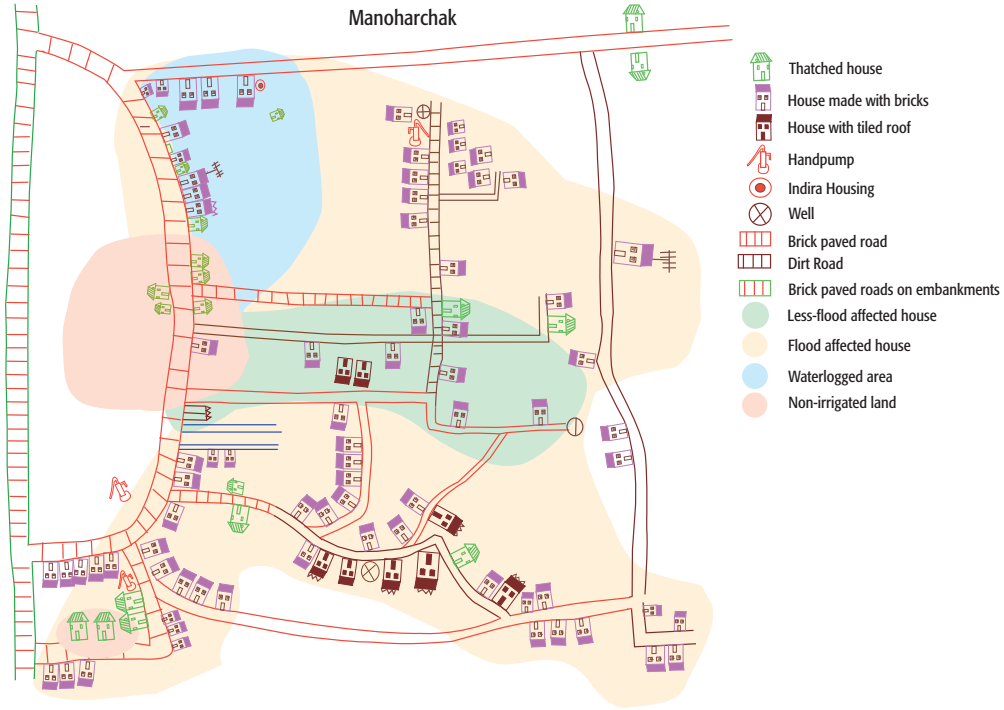
A profile of the selected village study sites is provided in Appendix 1 at the end of this chapter..

Manoharchak

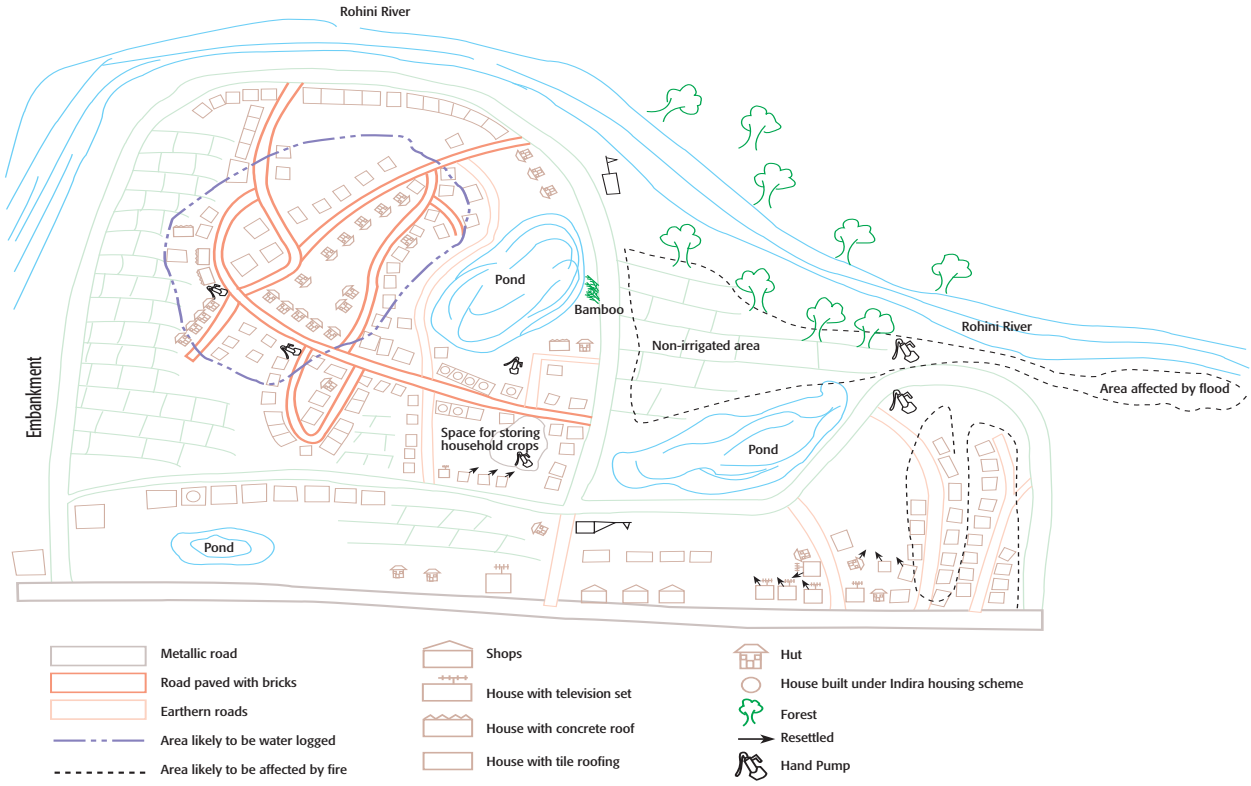
Manoharchak, a small village of just 104 households, is situated on the banks of the Rohini River, 40 km from Gorakhpur the district headquarters. Agriculture, the main source of income for the residents, is seriously affected by flooding caused by the 35-year-old Rohini River embankment outside the village. Although the embankment does check regular floods, it has also caused increasing waterlogging of agricultural fields. Most farmers own less than one acre of land and the village lacks basic water supply, sanitation and health services. Out-migration is high.

Lakshmipur

Lakshmipur, a village of 199 households, is situated on the banks of the Rohini River, 45 km from the district headquarters, Gorakhpur. It, too, is regularly flooded. Most of the agricultural land in the village is surrounded by embankments, which cause the land to become waterlogged during heavy rains. The irrigation department has an office in the village and regularly maintains the embankments. The village has a primary and a junior high school. Agriculture is the main source of livelihood, but migration has significantly increased as villagers seek an alternative source of livelihood.



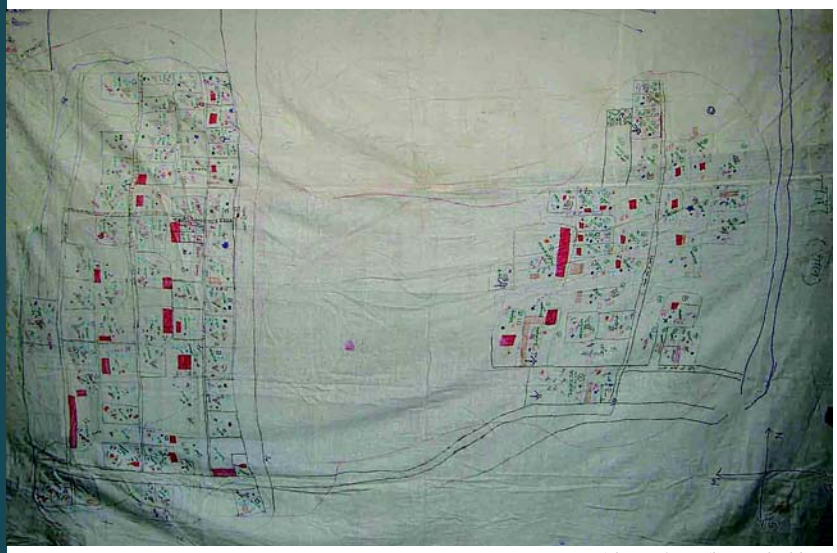
Social Map of Manoharchak



Social Map of Lakshmipur

Sonatikar

Located 45 km from the district headquarters, Sonatikar is situated at the edge of the Rohini River and is one of the most-flood affected villages in the region though a large embankment stands between the village and the river. The embankment prevents the rivers from overflowing into the village of 100 households but it also stops rainwater from draining out of the agricultural fields into the river. During periods of heavy rain, fields become waterlogged for two or three months. Almost half of the villagers have moved to the main road, which they say is safer during floods.



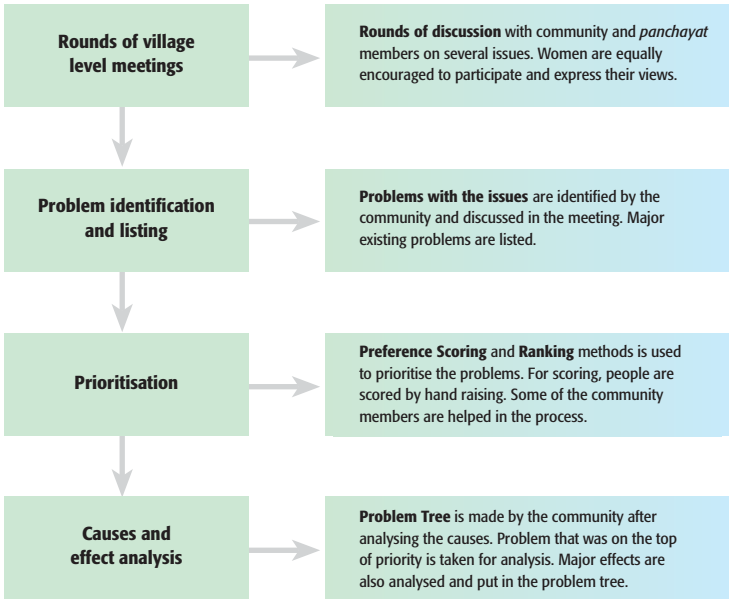
Social Map of Sonatikar on a bedsheet.

In all three villages, the majority of the farmers own less than one acre of land and fall into the "marginal farmer" category. Landless families depend upon seasonal agricultural labour for income. More details about the three villages and the issues and problems they face due to flooding are outlined in Appendix 2.

Methodology and Tools Used

The methodology for our study involved the implementation of vulnerability and capacity analyses through SLDs, while information from previous studies conducted in these villages was used to profile the characteristics of the area. Community groups as well as *panchayat* (local government) members participated in the SLDs held in each village. The problems and issues faced by each village as a whole as well as those faced by villagers individually were discussed.

FIGURE 2 | The process



Scoring and ranking methods were used to identify the most severe problems. Participants were asked to prioritise the problems that affected their village as a whole rather than those faced at an individual or family level. The strategy we adopted assumes working with households, communities and other local entities is an effective mechanism for identifying those factors that prevent or enable responses to events that could cause disaster. Without such consultations the problems faced by a small group of people or households within a community will be overlooked. In-depth discussions on the problems identified followed and social maps were used to analyse the causes and effects of each problem. This process is outlined in Figure 2.

Livelihoods

A social map was used to assess the occupation of each village by household. In addition to farming, residents in Maharajganj and Gorakhpur districts are engaged in daily wage labour, rickshaw-pulling, hair-cutting, and puffing food grains (*bhar*). They are also engaged in fishing, weaving fish nets, tailoring, owning grocery shops, owning tea shops, selling milk, vegetables and fruit carrying goods, doing unskilled labour in brick kilns and performing religious tasks.

Population and Migration

Migration is a popular way of adapting to floods. In the last several years, the search for jobs outside of the three villages has increased significantly. Young men in Lakshmipur, Manoharchak and Sonatikar would

rather not live in their birthplaces and work as farmers. The number of migrants has increased sharply as has the distances which people migrate. People's greater willingness to travel to distant places in search of livelihoods has increased local occupational mobility. The duration of migration has also increased. People often go away for one to one-and-a-half years, returning to visit their villages for only one or two festivals annually. At the end of this period, they return to the village for about three months and then emigrate again (see Table 1). One result of this rise in extended out-migration has been an increase in the incidence of HIV infection. Another is that with men away for longer periods of time, the impact of flooding is gradually becoming feminised.

People's greater willingness to travel to distant places in search of livelihoods has increased local occupational mobility.

Access to Services

Access to key services was mapped in order to understand the social structure within which communities function. The findings are summarised in the sections below.

Education Services

Table 2 presents a picture of the status of education obtained from the SLDs. Two indicators are given: the level of satisfaction and the distance from the village. In general, the higher the level of education an institution confers, the further it is from a village. Though primary schools are found in all three villages, the people are not satisfied with how they are administered, in particular, the lack of teachers, irregularity of classes, poor quality midday meals and poor facilities. The majority of children from poor families do go to primary school or *anganwadis*, but beyond junior high school, their participation decreases dramatically. The average distance to a primary school is about four kilometres and there is a junior high school in Lakshmipur. High school, intermediate and graduate level education, however, is beyond the reach of these villagers. On average students have to travel almost 18 kilometres to get to the nearest college at a cost which is prohibitively expensive. Thus, because of the high cost of

TABLE 1 | Migration Trends

Villages	Number of Households	Households with a migrant	Per cent	Migrated to	
				Local migration	Distant migration
Sonatikar	100	28	28	Brick kilns in Campierganj, Pipiganj and Gorakhpur	Delhi, Gujarat, Mumbai, Punjab and Haryana
Lakshmipur	134	64	48		
Manoharchak	80	37	46		

Source: Field survey, 2006

TABLE 2 | The Status of Education in the Studied Villages

Village	Anganwari		Primary		Jr. High/High		Inter college		Degree College	
	D	S	D	S	D	S	D	S	D	S
Sonatikar	1	0	1	4	4	5	6	5	18	3
Lakshmipur	2	2	0	7	0	5	7	9	19	7
Manoharchak	0.5	9	0.5	4	1.5	5	6	8	17	7

S : Satisfaction in quality of education (on a 0 to 10 point scale)
D : Distance from village (in kilometres)

Source: Field survey, 2006

transportation children of poor families are not educated beyond the primary level (see Table 2).

Health Services

Information on both government and private health services was assessed using diagrams which mapped the services provided against the opportunities to seek those services. As indicated in Table 3, the quality of government health services at the local level is poor. People often consult private doctors or visit a medical college for better treatment. Private practitioners and the staff at nursing homes have much greater credibility than the staff at government institutions. The one community health care centre available at the block level does function comparatively well and people are satisfied with its services. This centre is distant from the villages, however, and hence, in an emergency, no good quality services are available locally.

Agriculture Services

In the villages studied there are no agricultural facilities at the village level. For basic provisions such as seeds, fertilisers and pesticides, people must go to the block headquarters which is about 13 kilometres away. For other materials, such as tube wells and equipment and even some seeds, people must go to the district headquarters about 55 kilometers away. Agricultural co-operatives do exist but they are essentially defunct and people awarded them no marks for the criterion of satisfaction.

Food Deficiency Months, Coping Strategies and Livelihoods

Critical information about the duration of food deficiencies among the rural population, their strategies of coping with deficiencies and their livelihood options are summarised in the Table 4. Clearly, basic infrastructure related to health, education and agriculture is

People often consult private doctors or visit a medical college for better treatment.

TABLE 3 | Status of Health Services

Village	Private Doctors at village level		Primary Health Centre		Community Health Centre		District Hospital		PrivateNursing Home		Medical College	
	S	D	S	D	S	D	S	D	S	D	S	D
Sonatikar	3	0	-	-		37	2	1837	56	37	4	
Lakshmipur	5	2	4	10	7		-	2056	86	56	4	
Manoharchak	5	1	1	4	5	55	3	55	9	55	2	

S : Satisfaction of services provided (on a 0 to 10 point scale)
D : Distance from village (in kilometres)

Source: Field survey, 2006

TABLE 4 | Gap in Food Access

Basin	Food Gap (in months)	Strategy	Livelihood
Rohini Basin (Maharajganj and Gorakhpur districts)	i. Bhadra (Aug/Sept) ii. Falgun (March) iii. Magh (Feb/March)	The major coping strategy is to consume less food. Bread eaten with salt is the main food during these months. *Bhuja*, *Chiura*, *Sattu*, potato and a little sugar is also eaten. For some households, fasting is a major strategy for survival. At critical times, people are compelled to obtain credits from moneylenders by mortgaging agricultural lands.	People have no option other than doing labour on minimal wages. The wages earned hardly afford two meals for the family. People consider these periods as exploitative months.

Source: Field survey, 2006

lacking and reduces the adaptive capacity of these communities in times of disaster.

An attempt was also made to understand the service delivery roles of two important formal institutions – federal government extension services and *panchayats* in the context of disaster mitigation.

Role of Formal Institutions

Government extension services
External agencies like government functionaries and voluntary organisations play a vital role in disaster risk reduction. The construction of houses on higher grounds is an important step towards disaster risk reduction in flood-prone areas. Indeed, in Sonatikar, people were allotted lands on high ground to build their homes. Very little effort, however, was accorded to rehabilitation and relief services. Only during serious floods are food packets distributed and the maintenance of physical structures has been largely overlooked in all flood prone villages.

External agencies and voluntary organisations can play a vital role in disaster risk reduction.

Panchayats
The linkages between people and welfare schemes in each village were assessed. Though *panchayats* exist within revenue villages they are practically defunct and people are not satisfied with their work. In fact, the prevailing sentiment is that these local governance units have become agents of politicians and higher authorities and that most are corrupt – particularly in terms of how beneficiaries for welfare schemes are selected. The stated beneficiaries often receive nothing, while wealthy people with access to power and money enjoy substantial benefits. Only people from Lakshmipur were satisfied with the role of the *panchayat* during floods. They believe *panchayat* committees properly distribute relief materials to villagers.

Natural and Climate Hazards

Eastern Uttar Pradesh is frequently subjected to flooding, due to its topography and heavy rainfall. Most communities know little about the impacts climate change may have on the already difficult local conditions. Since climate change information is still emerging, incorporating insights into risk reduction strategies will require effective strategies for a two-way dialogue. The challenge is to communicate the often abstract and technical insights from global science into a discourse meaningful to local communities. At the same time, the communities have to develop and understanding and communicate the potential implications of climate change on their livelihoods. The importance of shared learning is, as a result, central to identifying effective strategies for adapting to climate change. In addition, as enabling and constraining factors at the community level often have roots in high-level systems (financial, policy, and institutional), we need to be able to identify high-level points of entry and work with actors operating at the relevant regional, state, or national levels.

Patterns of Vulnerability

Vulnerability is locally based and must be analysed and understood in context.

Climate change impacts are, and will be, different on all scales. This means that different regions, different social groups and different individuals will face different, diverse and unequal impacts and difficulties in coping with climate change. This makes *vulnerability* to climate change differ too. Hence, vulnerability is locally based and must be analysed and understood in context. Vulnerability can be defined simply as a *set of conditions and processes resulting from physical, social, economic, and environmental factors which increase the susceptibility of a community to the impact of hazards.*

Factors that increase the ability of people and the society they live in to cope effectively with hazards, that increase their resilience, or that otherwise reduce their susceptibility are considered as their capacity to cope with disaster. Capacity varies depending on factors like poverty, gender, caste (social inclusion), age, physical and mental ability, or what is known as *everyday vulnerabilities.*

Capacity and vulnerability analysis (CVA) was used as a tool to assess the vulnerabilities extant in the three villages studied (see Table 5a, 5b, 5c). Social mapping and community group discussions were also used. The findings about the existing village-level vulnerabilities and capacities, information that is necessary for further intervention are summarised in the tables below.

Changing Nature of Vulnerability

Vulnerability is dynamic and context-dependent. A farming family, for

TABLE 5a | Capacity and Vulnerability Analysis Lakshmipur

	Vulnerability	Capacity
Physical/Material	- Over 75% of households own less than one acre of land - Around 50 acres of agricultural land is waterlogged - Around 250 acres of agricultural land is under-irrigated - Health centres do not function; the satisfaction level for these is low - Only 5-6 hours of power supply a day - local food supplies only last six months of the year - Drought is as a problem	- Embankment for refuge during floods - Irrigation Department office exists - Access to road - Market is 7 km away - knowledge of building temporary bridge during flood - 12 individuals have mobile phones and 36 households have television - 3 Public Call Offices - Primary and junior high schools
Social/Organisational	- Defunct *gram panchayat* - Caste divisions during elections - 50% of households have members who migrate out, migration of youths is increasing - No formal group like Mahila Mandal and no self-help group	- Puja committees (Durga, Saraswati) exist - Decentralised roles and responsibilities in group work - Youth sports team - Physical and moral support during floods
Motivation/Attitude	- "Flood is our destiny" and "We cannot get external support" are accepted mantras - Depend on government/*panchayat* to maintain hand pumps, tube wells	- Readiness to work together - Demand for new agriculture techniques - Participation in community meetings - Willingness to obtain new information - Readiness to contribute to resources

TABLE 5b | Capacity and Vulnerability Analysis Manoharchak

	Vulnerability	Capacity
Physical/Material	- Over 80% of households own less than one acre of land - Health centre does not function well; visits by medical worker are irregular - Only 5-6 hours of power supply a day - Local food supplies only last six months of the year - Very few natural water reservoirs; deep water table (60-65 feet) - A large number of eligible families have no Below Poverty Line (BPL) ration cards	- Embankment for refuge during floods - Village electrified - Functional ITC: e-chaupal internet connectivity - Connected to road - Market is 8 km away - Knowledge to build temporary bridges and roads during floods - Mobile phone network available - 1 Public Call Office
Social/Organisational	- Defunct *gram panchayat* - Caste divisions during election period - 47% of households have members who migrate; migration of youths is gradually increasing - No formal group like Mahila Mandal and no self-help group	- Puja committees - Decentralised roles and responsibilities - Mutual physical and moral support among people in disaster situations
Motivation/Attitude	- Sense of hopelessness in obtaining any government or *panchayat* support - No faith in *panchayat* - Depend on *panchayat* to repair tube well and for health centre	- Some community members are active and encourage others - Demand for new agricultural techniques - Participation in community meetings - Willingness to seek new knowledge - Readiness to contribute to resources

TABLE 5c | Capacity and Vulnerability Analysis Sonatikar

	Vulnerability	Capacity
Physical/Material	- Over 80% of households own less than one acre of land - High number of landless families - Health centre and schools do not exist in village - Half of the village is not electrified - Local food supplies only last for six months of the year - A large number of eligible families do not have Below Poverty Line (BPL) ration cards - A large area of agricultural land is waterlogged (around 100 acres) - Land is waterlogged for 2-3 months	- Embankment for refuge during floods - Half of the village is electrified - Connected with road - Urban market is 8 km away - Knowledge of building temporary bridges and walkways during floods - Mobile network is available - 1 Public Call Office
Social/Organisational	- Defunct *gram panchayat* - Caste divisions during election - 28% of households have memebers who migrate; migration among youths is increasing - No formal group like Mahila Mandal and no self-help groups	- Puja committees - Decentralised roles and responsibilities - Mutual physical and moral support during disasters
Motivation/Attitude	- Poor faith in *panchayat* - Dependent on government/*panchayat* to maintain hand pumps, tube wells - People are not interested in collective work	- Some community members are active and influence others - Demand for new agricultural techniques - Community members participate in meetings and discussions - Willingness to obtain new knowledge - Readiness to contribute to resources

example, may be more vulnerable to floods, than a landless family is. Spatial and time factors play a crucial role in defining vulnerability too.

In terms of their vulnerability, poor families or communities are broadly classified as improving, coping or declining.

Poor people can move through these three classifications over the course of a month or year. Just as there are cases of people 'coping' with a disaster situation moving to the 'improving' category by virtue of increasing their incomes through out-migration there are also incidences of people who fall from 'improving' all the way down to 'declining'. It is important to document changes in coping status which are influenced by income level as income is the real agent of change.

Gender is clearly an indicator of vulnerability, specifically in relation to health, education, mortality, economic participation, decision-making and safety. As a result of proactive measures taken in the past, gender gaps in literacy appear to be narrowing in those states where the disparity between men and women was once high (according to the 2001 population census).

Although the poor are adversely impacted as a whole, women and girls are the most vulnerable among them because they have little voice in decision-making. In rural areas dominated by men and elites, women often are not well represented politically, are neither consulted nor included in development planning processes, and, as a result, cannot voice their ideas about how services should be designed.

Sand bags placed for preventing further degradation of embankment at breached section.

Women and girls find it difficult to participate in consultations for several reason. Some of these are:

- socio-cultural barriers
- poor timing (timings that conflict with chores women are obliged to carry out) and inappropriate venues for meetings (places where women are not allowed)
- inability to travel freely
- lack of free time.

The 74th Constitutional Amendment (1992) has enshrined a structural basis for women's participation in political decision-making and for bringing them into the mainstream of development. The process of actually empowering women and promoting gender balance, however, is in a nascent stage. Numerous constraints need to be overcome to ensure that women participate effectively.

Numerous constraints need to be overcome to ensure that women participate effectively.

Shared Learning Dialogue

The process of SLD is based on reflexive learning from other positions and perspectives. It is distinguished from the rigid certitude of mono-disciplinary styles, especially those of single-mission outfits which advocate top-down, structural solutions to mitigate the impact of floods and droughts. SLD is built around the idea of introducing the insights of social sciences into vulnerability and risk assessment. While technical experts know much, villagers suffering from floods and droughts know many of the social and environmental contexts in which they cope with the disasters still better. Using the SLD method, this study aimed to understand local concerns and knowledge and to integrate them with proposed pilot interventions.

Using the SLD method, this study aimed to understand local concerns and knowledge.

We undertook various activities to engage with different groups at different levels and scales so that we could gain insights into issues that may have been missed by focusing only on a single perspective. Learning through SLD involves engaging in discussions with representatives from government, market and civic movements on issues relating to adaptation, livelihood and mitigation, reviewing existing mitigation strategies, and establishing communication links among different groups.

Since government bureaucrats, market players and activists define a problem or disaster event differently, they each support different policy measures. As is the case in the SLD paradigm, policy reviews were begun at the lowest level, with the communities affected by disasters. Market players were asked to describe constraints to provide cheaper and more efficient solutions and activists was asked to challenge and examine the issues of fairness affecting those communities. The relevant government departments were provided with recommendations for implementation procedures that could address the concerns of all three sets of actors. These recommendations focused on innovation, fairness and effective regulation. The findings from the SLDs that were conducted are summarised in Table 6.

Key Points from the SLDs for Strategies:

- Varied perceptions on hazards emerged. Although overall, at the village level, droughts and floods are perceived to be a common disaster, the village level definition of a hazard often did not equate with the official definition. For example, villagers define drought as those periods when their crops require water and there is no rainfall. This definition is different from that used by the state government which defines drought based on the deficit in total volume of annual rainfall relative to normal volumes.
- Early flood warning systems need to devolve beyond the region, district or block level to the village level. The villagers of Lakshmipur suggested

TABLE 6 | Summary of Findings from Shared Learning Dialogues

Level	No of SLDs	Stakeholder	Description
Village	5	Community representatives from local government and NGOs	First SLD in five villages discussed the nature of disasters and associated risks. This area is highly flood prone but drought is an emerging hazard as the monsoon is becoming more erratic.
Block	1	Block Development Officer (BDO), Assistant Development Officer (ADO), Media, *panchayat* officials, block level government officials.*	Main points of earlier SLD shared. Stakeholders' views on flood and rehabilitation explored. District administration (DA) identified as prime authority to implement rehabilitation programme and BDO and ADO perform as instructed by the DA. Compensation assessment not the responsibility of DA. Officials agree damage assessment process is not transparent. Crop insurance can be an effective tool.
State	1	NGOs, Catholic Relief Services (CRS), Oxfam, Church's Auxiliary for Social Action (CASA), Radio and TV, Project thematic partners, District and State disaster management cell	A short discussion on the present scenario of floods and other disasters in Eastern UP including the nature and frequency of flood and ecological change due to disaster. Discussion of communication needs and systems at village, block, district and state level during disaster, and policies on disaster mitigation and rehabilitation.
Panel discussion on crop insurance in during Jan Sansad	1	Attended by about 1,000 farmers and NGOs, chaired by senior administrative officer who shared his views on farmer's rights.	Crop insurance and compensation was one of the major issues discussed. Farmers from flood and drought affected regions suggested that efforts should be made to raise the issue of insurance and compensation. Present mechanisms and policies on crop insurance and damage assessment is complicated and beyond the reach of the community.

*Dialogue is planned for Paniyara Block.

that if they could receive information on water levels, then preventive measures could be taken to save their assets, including crops. Currently people get some information on the probability of a flood event through newspapers and the radio. Such information is not considered specific enough, however, for people to determine if their village is likely to be affected or not. Currently, villagers monitor river water levels next to their village on their own. They use river level assessments to make judgments on whether or not a flood event is likely.

- Farmers were interested in knowing about suitable alternative crops that they could cultivate to minimise crop damage due to floods or poor rainfall. These could include early-sowing short duration crops that can be harvested before the onset of the flood season (July-August) and crops that can survive waterlogged conditions.
- Seasonal migration helps local communities that are regularly affected by floods to cope with the losses incurred.
- Interventions and actions are needed at different levels—household, community groups and village levels.
- At levels higher than the field level, questions of who should undertake what activities leads into the questions of what needs to be done for adaptation and disaster risk reduction.
- During the SLD process, several issues were raised regarding high frequency disasters with low impacts *versus.* low frequency disasters with high impacts. Three important questions emerged which stakeholders felt are important to

Preventive measures could be taken to save their assets, including crops.

consider while designing disaster risk reduction strategies:

a. How do we sustain proposed adaptive strategies for DRR (insurance, communication mechanisms, early warning systems) for low frequency / high impact disasters?
b. In developing adaptive strategies, should the focus be on high frequency and low impact disasters, while nonetheless keeping high impact events in mind?
c. How do we integrate adaptive strategies overall development?

It was also pointed out that market and larger political dynamics can exacerbate the vulnerability of local communities.

SLDs help gather people's perceptions of the costs and benefits of disaster risk reduction.

- The various representatives of government departments we interacted with through SLDs were defensive at first but tended to provide achievable, incremental "options for the way ahead" for disaster interventions;
- As a tool, SLDs allow for continuous engagement with stakeholders, which is much more meaningful than simply getting feedback from them as it allows the project team to share experiences and findings. SLDs are inclusive and integrative because stakeholders at all levels understand that these discussions are not a one-off exercise but rather a forum for continuous discussion;
- SLDs help gather people's perceptions of the costs and benefits of disaster risk reduction strategies: embankments as a preventive measure against floods can be both a boon as well as a bane. The embankment in Lakshmipur is a case in point. The ring bund embankment was constructed 35 years ago. In 2001, the embankment protected the village from floods, but later it breached, washing away part of the village and forming a large pond on arable land. The ring bund also prevents flood water from draining properly, resulting in waterlogging. Though the soil is fertile, agricultural productivity has been adversely affected. The Irrigation Department has neglected its responsibility for maintaining the bund. As a result, the threat of its breaching and inundating the village is constant.
- In addition to discussing field based issues, the state level SLD, also broached policy requirements. This forum allowed for a discussion and recognition of community needs and possible policy changes called for. This SLD also helped explore how best to translate policy into action.

Who is Vulnerable?

From the foregoing, it becomes clear that SLDs have helped identify patterns of vulnerability in project villages, and, more specifically, those factors which promote or prevent household adaptation to floods. Villagers used several specific indicators to identify vulnerable households, including susceptibility of physical assets such as houses and agricultural land to damage inability to cope with or recover from a disruption in the supply of primary services such as water supply, sanitation and health; and the inability to maintain household income, especially during the post flood periods, due to excessive or sole dependence on livelihood systems affected by floods.

TABLE 7 | Vulnerable Groups

Vulnerability Attributes	Manoharchak (% households)	Lakshmipur (% households)	Sonatikar (% households)	Remarks
I) Susceptible to physical damage (houses)				
a) houses	31	22		*Kachchha* dwellings prone to damage
b) inundation of agricultural fields	25	-		Loss in crop production
II) Access to safe drinking water, especially during floods	75	75		Contamination of handpumps due to flood waters
III) Access to sanitation facilities, especially during floods	100	100		Toilets and open areas for defecation remain inundated
IV) Inability to recover from loss of livelihood incomes				
a) Inability to take at least one extra crop	80	75-80	100	Waterlogged lands due to floods constraining them to take only one crop after flood water recedes
b) Lack of irrigation facilities post floods	70	85	70	Lack of access to irrigation technologies resulting in loss in production
c) Low income groups (landless)	28	10	40*	No alternative income source to agricultural labour
V) Lack of access to information and early warnings	100	100	100	People are unaware of alternative income generation activities and do not have access to effective warning system

* includes marginal farmers who are dependent on big farmers

A cursory look at Table 7 reveals that a significant proportion of households are more at risk because of vulnerability factors related to during-flood and post-flood periods than because of physical damage due to floods. A key factor making a community vulnerable is the lack of a diversified agricultural system and of income avenues not affected by flood impacts. The most vulnerable group is the landless, who are heavily dependent on agriculture labour for generating household income.

Who Should One Work With?

SLDs at different levels not only point out possible development interventions but also reveal the mechanisms (or roadmap) for achieving them. Different stakeholders can take on distinct roles in their aim to achieve the common goal of disaster risk reduction. Government officials agreed, for example, that damage assessment in post-disaster scenarios is not transparent and that existing relief and rehabilitation systems are deficient, but felt that crop insurance could emerge as an effective tool to minimise the losses of disaster.

It is important to recall that the government has been mandated with the task of governance and that there should be no duplication of service delivery. Instead, the existing government system needs to be complemented. Treating the

The landless are heavily dependent on agricultural labour for generating household income.

government as a monolithic institution does not improve local level situations either. It is the existing disaster management cell which has been mandated to undertake activities for disaster risk reduction that needs to play a key role in the delivery of services.

Communities impacted by disasters are the target groups for developing pilot intervention activities. While there is a tendency of doing too many things at one go, especially in the context of disasters, it is more important to exercise restraint and design interventions that are incremental and achievable. The involvement of communities through SLDs can lead to effective diagnosis and throw open options. SLDs at different levels can target achievability in the delivery of services.

SLDs serve as a key tool for civil society institutions and the media to engage with each other. They also help donor communities adopt a consensual approach rather than, as is typical in disaster risk reduction interventions, being donor-led. Pilots and briefs (supported by donors) can go a long way in moving towards achieving bottom-up initiatives.

Banks and traders can also contribute towards improving conditions in rural communities. The focus should be on business rather than on philanthropy through social responsibility initiatives. Presently, the private sector, banks, traders and insurance communities hide behind the sophistry of 'systems for and policies on crop insurance and damage assessment are too complicated for rural communities' rather than using these mechanisms for risk reduction. To widen the reach of disaster risk reduction solutions we also need to generate space for market actors. First, though, the existing data gap needs to be filled and key insights into how that aim could be achieved needs to be generated.

We also need to generate space for market actors.

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Embankments are sites of refuge during floods.

TABLE 8 | Pilot Adaptive Measures for the Three Study Villages

	Lakshmipur	Sonatikar	Manoharchak
Description of Village	Population-1765 (M-726, F-679, C-360), agriculture land- 125 ha, irrigated-95 ha, non irrigated-30 ha, Total HH-199, majority of small farmers (80%)	Population-525 (M-242, F-198, C-85), agriculture land- 78 ha, irrigated-68 ha, non irrigated-10 ha, Total HH-100	Population-467 (M-198, F-186, C-83), agriculture land- 45 ha, irrigated-29 ha, non irrigated-16 ha, Total HH-104
ADAPTATION SPECIFIC INTERVENTIONS			
Diversification			Early maturing and water standing crops, fodder conservation
Ecosystem			
Disaster Risk Reduction	Provision of irrigation pumps, maintaining and disinfection hand pumps, drainage pipes construction but depending upon support of local people (on both sides embankment and road)	Provision of community tube wells, maintaining hand pumps	Provision of community tube wells, maintaining hand pumps, training on hygiene toilets making and raising, immunisation of children and livestock
Organisation and Incubation	Self managing institutions, formation of farmers groups, village health committee, establishing village resource centres, SHG formation	Self managing institutions, formation of farmers groups, establishing village resource centres, SHG formation	Self managing institutions, formation of farmers groups, establishing village resource centres, SHG formation, health committee
Skill Development	Awareness programme and training (intensive farming, design and construction of portable raised toilets, personal hygiene	Awareness programme on disaster mitigation and training (intensive farming, vegetable production, seed production, water standing crops, composting etc., personal hygiene)	Awareness on disaster mitigation, trainings, exposure visits
Financial and Risk Spreading	Income generation activities such as- mushroom production, goat raring, fishery, poultry, candle making etc.	Income generation activities, such as mushroom production, goat rearing, fishery, poultry, candle making etc.	Income generation activities, such as mushroom production, kitchen gardening, goat rearing, fishery, poultry, candle making etc.
Communication	Information centre at village level, early warning, communication centres, community radio (FM), mobile phones	Information centre at village level, early warning, communication centres, community radio (FM), mobile phones	Information centre at village level, developing early warning system through mobile, phones, community radio (FM) but depending upon external stakeholder's support
UNDERLYING SYSTEM FOR ADAPTATION			
Education	Training on seed production, Kissan Credit Card, crop insurance, ensuring availability of IEC materials, exposure visits	Training on seed production,vermi and nadep composting, ensuring viability of IEC materials, exposure visits, Kissan Credit Card and crop insurance	Training on KCC, crop insurance, ensuring availibility of IEC materials through resource centre, exposure visits
Transport	Boats, bamboo bridge	Boats, bamboo bridge	Boats, bamboo bridge
Financial Mechanism	Linking banks with the self help groups/ savings and credit organisations	Linking SHG with bank, inter loaning	Linking SHG with bank, inter loaning
Organisation	Community irrigation management, setting up systems for community contribution to repair water pumps	Community irrigation management	Community irrigation management, *shram daan* by people to drain excess water
Livelihood	Off season vegetable and mushroom farming, seed production, kitchen gardening and vermicomposting	Off season vegetable and mushroom farming, seed production, kitchen gardening and vermicomposting	Vegetable and mushroom production, seed production, kitchen gardening, nursery raising, vermicomposting, goat rearing, fishery, incense stick making, candle making etc.

Pilot Activities

Disaster risk reduction also needs technological innovations.

The disaster risk in the project villages can be mitigated by targeting the following activities:

a) **Direct risk reduction interventions:** These include agricultural interventions relating to inundation-resistant and early sowing and / or harvesting crops, irrigation technologies enhancing access to irrigation, spreading financial risk through crop insurance, innovative models of sanitation and handpumps, housing technology resistant to floods, and early warning systems.

b) **Interventions for changing underlying systems for adaptation:** These include adaptation incubation systems that support self-managing people's institutions for continual innovations in agriculture and communication and improvement in education, health and transport systems.

While the above-identified activities emerged from SLDs, the activities that are actually piloted will need to be carefully selected after validation by the community in the next round of SLDs.

Flood damaged cash crops and paddy: 2007 monsoon, Eastern Uttar-Pradesh

Summary of Key Insights and Conclusions

SLD is a two-way process of knowledge transfer.

- Capacity and vulnerability analyses and SLDs at different levels help point out disaster risk reduction strategies. This study establishes that both these tools do work and that they generate multi-faceted benefits in terms of generating, validating and triangulating data, engaging stakeholders, and supporting policy advocacy. Most importantly, they also help identify potential ideas and mechanisms for development interventions.
- At the field level, SLDs conducted with disaster-affected communities not only serves as a platform for sharing experiences but also helps identify useful solutions to problems identified by the community;
- SLD is useful in building the capacity of both community members and the project team;
- SLD is a two-way process of knowledge transfer. For example, we communicate technical details of global warming to local communities while they explain to us the existing and expected impacts at the field level in terms of occupational mobility, migration patterns, livelihood systems, etc.;
- This two-way flow of information regarding knowledge about climate change impacts and their (tangible and indirect) impacts needs to be interposed with the understanding the community possesses. These set the stage for making decision on key points of action;
- Solutions emerging in SLDs need to be documented and shared with stakeholders during further SLDs and/or in meetings with policy-makers;
- SLDs need to be more participatory, in particular women and other marginalised groups need to be more involved;
- SLDs can function as a tool for triangulation and validation;
- System and process delivery needs, including those related to policies, should be identified at all levels. The SLD process can be viewed as a horizontal process: more and more SLDs and more 'solutions' have to be identified and promoted through dialogue as one moves across scales.

Weaknesses of the Methods and Concepts

1. One of the weaknesses that emerged is that the process of SLDs requires intensive inputs in terms of both money and time.
2. So that too many ideas do not float around in a SLD and discussions do not veer away from the agenda, there is a need for effective moderation. Who should assume the role of moderator is problematic. If project personnel adopt the role, their guiding the discussions can be seen as a form of bias.
3. Contentious issues such as land rights sometimes take the centre stage in these platforms.
4. Some priority areas such as gender-sensitive approaches get low priority if not handled carefully.

Appendix 1

Profile of Project Villages

Village : Sonatikar
Block : Campierganj
District : Gorakhpur

1. Population:

Men	Women	Children	Total
242	198	85	525

2. Types of Houses:

Kaccha	Pakka	Phoos	Total
32	52	16	100

3. Castewise Population

Caste	No. of Household	Population	
		Male	Female
General	7	17	14
Backward Class	68	202	165
Other Backward Class	5	11	09
Schedule Caste	20	58	49

4. Number of Households with Toilet : 4

5. Total Agriculture Land Area : 78 ha
Irrigated : 68 ha
Non irrigated : 10 ha

6. Literacy

Male	Female
60%	40%

7. Number of Handpumps

Private	India Mark
38	12

8. Area open / Under forest : 2 ha

Village : Manoharchak
Block : Paniyara
District : Maharajganj

1. Population:

Men	Women	Children	Total
198	186	83	467

2. Types of Houses:

Kaccha	Pakka	Phoos	Total
12	72	20	104

3. Castewise Population

Caste	No. of Household	Population	
		Male	Female
General	7	23	18
Backward Class	70	134	121
Schedule Caste	27	88	83

4. Number of Households with Toilet : 2

5. Total Agriculture Land Area : 45 ha
Irrigated : 29 ha
Non irrigated : 16 ha

6. Literacy

Male	Female
70%	30%

7. Number of Handpumps

Private	India Mark
26	07

8. Area open / under forest : 0 ha

Village : Lakshmipur
Block : Paniyara
District : Maharajganj

1. Population:

Men	Women	Children	Total
726	679	360	1765

2. Types of Houses:

Kaccha	Pakka	Phoos	Total
13	156	30	199

3. Castewise Population

Caste	No. of Household	Population	
		Male	Female
General	19	59	51
Backward Class	116	656	631
Other Backward Class	29	68	53
Schedule Caste	35	128	119

4. Number of Households with Toilet : 7

5. Total Agriculture Land Area : 225 ha
Irrigated : 125 ha
Non irrigated : 100 ha
Irrigated Land : 95 ha
Non Irrigated Land : 30 ha

6. Literacy

Male	Female
60%	40%

7. Number of Handpumps

Private	India Mark
45	7

8. Area open / under forest : 100 ha

Appendix 2

Issues and Problem Identification in Flood Affected Villages

Manoharchak

Main Problems

Identified problems related to flood are as follows:

- Unavailability of fertilisers and seeds on time
- Lack of electricity
- Lack of irrigation water
- Lack of safe drinking water and sanitation for villagers
- Inaccessibility to govt. welfare schemes (BPL cards, Antyodaya cards etc.)
- Lack of labour work at village level

Followings are the problems according to the priority:

1. Lack of Irrigation facilities
2. Lack of safe drinking water and sanitation
3. Inaccessibility to govt. welfare schemes (BPL cards, Antyodaya cards etc.)
4. Unavailability of fertilisers and seeds on time

Lack of Irrigation Water

Causes

There are several causes that are contributing to lack of irrigation water.

(i) There is a community tubewell in the village but it is not working in the absence of proper maintenance. The *panchayat* which is accountable for its maintenance is not looking after it properly.

(ii) Most of the farmers have very small land holding and they do not have resources to buy pumping sets or other irrigation equipment. Hence they often hire the pumps from big farmers.

(iii) Lack of electricity is one of the causes. Only 5 to 6 hours of power supply is available. Power cuts often create problems for farmers to assess the full benefit. Irrigation tubewells which require regular supply of power cannot be operated. Maintenance of electric equipment such as a transformer is the prime responsibility of the *gram panchayat*. But this institution does not even undertake simple repairs.

(iv) Low water level increases the cost of deep boring and pumping. According to farmers, where the water table is deep, farmers are not able to invest in pumps or individual tube wells. Generally tube wells are set at 65-70 feet.

(v) Irrigation canals are not properly managed and hence interrupt the irrigation process.

(vi) The villages have limited surface water resources. There is no pond close to agriculture land. Carrying water from the river is an arduous job for farmers because there is an embankment between the village and the river. Long irrigation pipes fed by a powerful pumping set would be necessary, which would increase the cost.

Effects

(i) Lack of water for irrigation decreases crop production. In the last few years the area has been affected by drought. This is affecting the main *kharif* crop (paddy).

(ii) As a result farmers are forced to hire the pumping sets and irrigation pipes. Both add to direct cost.

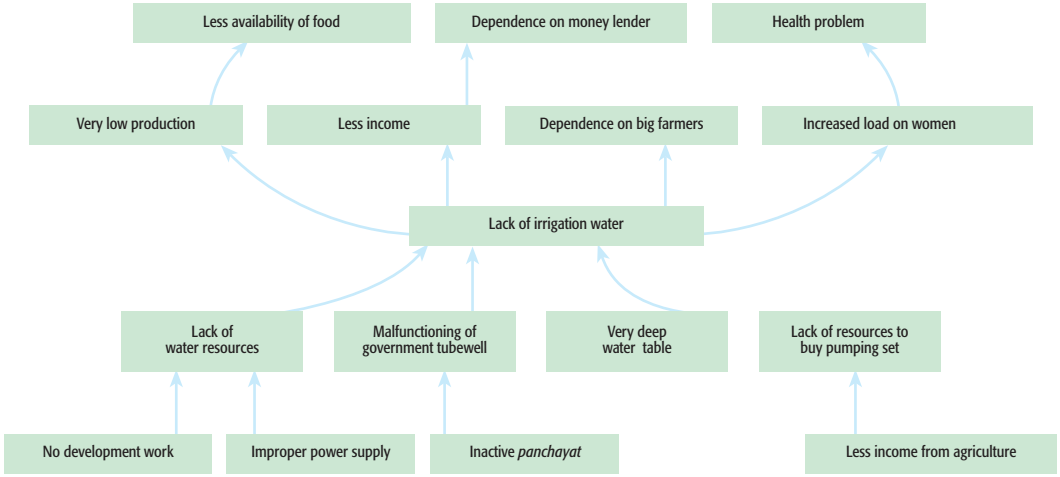
(iii) Repeated flood and new drought has detached farmers from agriculture as the work cost of farming is increasing. Migration has significantly increased.

(iv) The load on women has increased significantly. Apart from other household chores, they are also involved in irrigating lands using hand pumps. Overall their health status is affected.

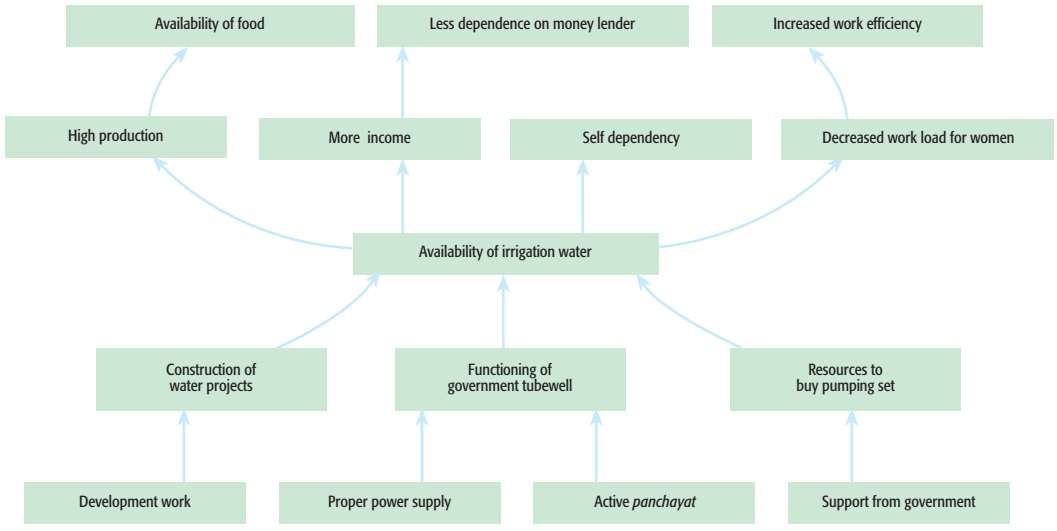
Community's Perspective of Pilots

- The government should help install tubewell of high capacity
- Uninterrupted power supply especially during *kharif* season
- Ensure availability of irrigation pipes for small farmers
- Irrigation canals should be lined.

Problem Tree - Manoharchak



Solution Tree - Manoharchak



Sonatikar

Identified Problems

- Lack of irrigation facilities
- Lack of adequate safe drinking water and sanitation
- Single crop in a year
- Villagers lacking BPL card, ration card.
- No health facilities

Problems on Priority Basis

1. Single crop in a year
2. Lack of irrigation facilities
3. Waterlogging in agricultural fields
4. Inaccessibility of BPL cards to the eligible families
5. Lack of adequate safe drinking water and sanitation.

Single Crop

Sonatikar is highly affected by flood. This is primarily a farming community that gets one cropping season (*rabi*) in a year.

(i) Waterlogging of agricultural fields during periods of heavy rain is common. *Kharif* crops are inundated for 2-3 months. The village situated on elevated land (main road) is less affected by heavy rain. Embankment does not allow rain water to drain.

(ii) Standing water remains for 2 to 3 months and affects sowing of *rabi* crops.

(iii) Crop productivity has been lowered due to waterlogging. Land fertility has also declined.

(iv) Farmers avoid sowing paddy crop in *kharif* season because they think that sudden of flood event could cause damages.

(v) There is a lack of knowledge about deep groundwater as well as about early varieties. Farmers do not take any crop in *kharif* season because they do not have knowledge about the early and deep water varieties which can be grown in flood prone regions.

(vi) Lack of proper irrigation causes low production of *rabi* crops. Most farmers have small land holding and their income is low. Irrigation facilities are unavailable. Farmers have no option except to hire wells from larger farmers or from the market.

Effects

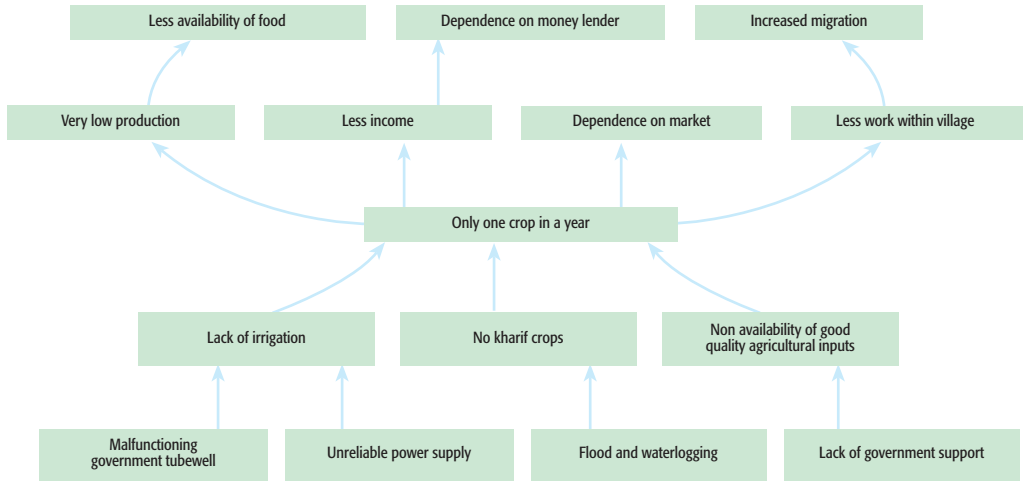
(i) Agricultural produce fetches poor prices.
(ii) Food is available for only six months
(iii) Compelled to take credit from money lenders

(iv) Farmers are detached from agriculture
(v) Increase in out migration

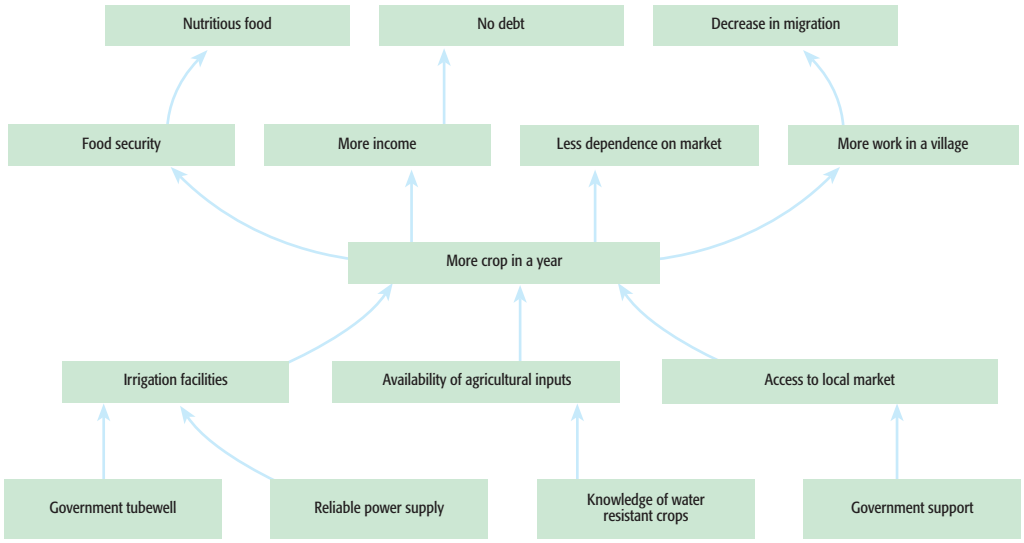
Community Perception on Further Action

- Dissemination and knowledge about water resistant varieties
- Availability of tubewells
- Training on modern farming technologies to minimise the cost of production
- Subsidy on agricultural inputs should be increased to minimisethe cost of production

Problem Tree - Sonatikar



Solution Tree - Sonatikar



Lakshmipur

Identified Problems

- Lack of safe drinking water and sanitation
- Lack of irrigation water
- Waterlogging of fields
- Farmers get only one crop in a year
- Migration of youths in search of livelihood

Problems on Priority Basis

1. Lack irrigation facilities (around 250 acres are under irrigated)
2. Single crop a year
3. Waterlogging of agriculture field (around 50 acre of land is water logged)
4. Migration of youths
5. Lack of adequate safe drinking water and sanitation.

Lack of Irrigation Facilities

Causes

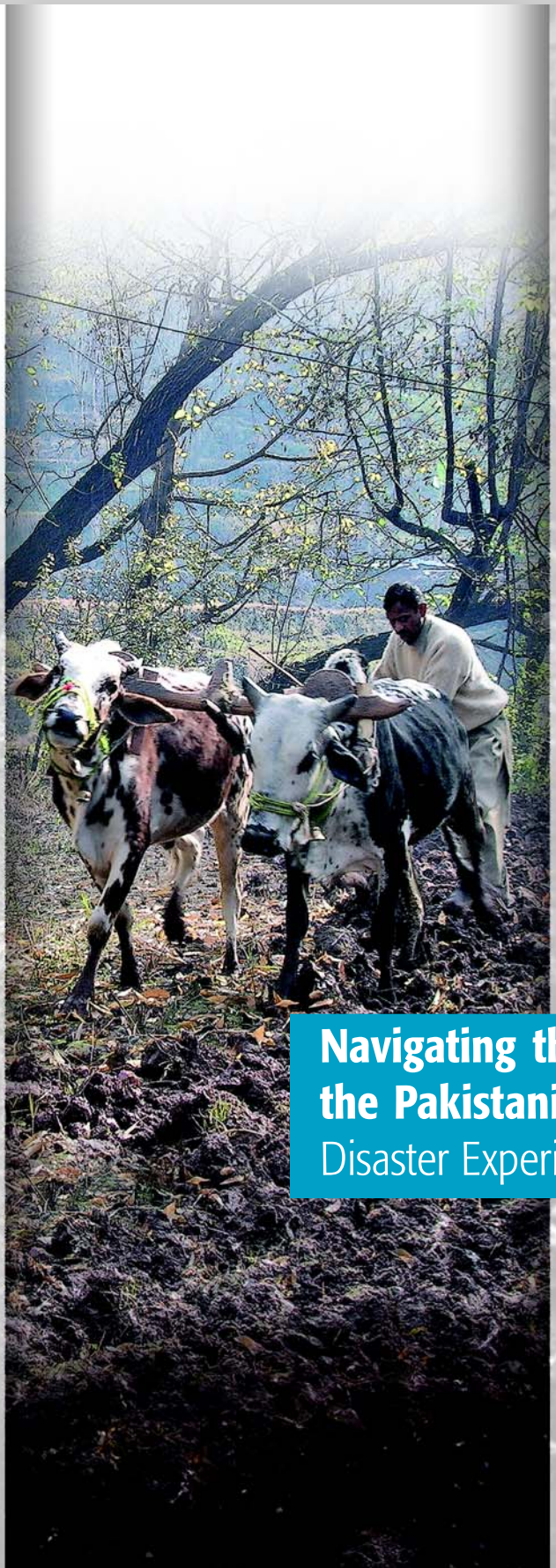
- Most of the agricultural lands are under irrigated. About 250 acres of land are quite affected by lack of water. Water cannot stay in these agricultural lands because of the high land.
- Malfunctioning of community tubewell is a major problem. It is does not work due to absence of timely maintenance and repairing.
- Lack of electricity increases dependency on fossil fuel. Farmers buy diesels but incur high cost.
- Most of the farmers are small holders and do not possess resources to buy pumping sets. They are compelled to hire the sets from big farmers.
- Lack of water resources also affects irrigation.

Effects

Increase in cost of production due to dependence on groundwater irrigation.
Decrease in *kharif* crops.

Some farmers cultivate *kharif* crops because their lands are not close to embankment.

Migration in search of livelihood is increasing. There are few incentives for the younger generation to stay in agriculture based livelihoods.



8

CHAPTER

Navigating the Contours of the Pakistani Hazardscapes: Disaster Experience versus Policy

Fawad Khan and Daanish Mustafa

Case Study Guidance Note

Country: Pakistan
Location: Rawalpindi/Islamabad and Muzaffarabad (Pakistani Administered Kashmir)
Date: May 2007
Sector and Spatial focus: Urban hazards, river basin, livelihoods, Disaster Risk Reduction, mountain hazards, floods, earthquake
Title: Navigating the Contours of the Pakistani Hazardscapes: Disaster Experience versus Policy
Bibliographical reference: Fawad Khan and Daanish Mustafa (2007), Navigating the Contours of the Pakistani Hazardscapes: Disaster Experience versus Policy

Abstract

Pakistan, despite being the seventh most populous country in the world, has not been able to muster much international scholarly attention towards its galaxy of human-environment interaction related issues. Two contrasting cases are reviewed in this chapter, namely: Muzaffarabad earthquake affected areas and the Lai basin in Rawalpindi. While the primary hazards in case areas vary in cause, frequency and intensity, the comparison between disaster risk reduction approaches and their likely outcomes is very instructive. The catastrophic South Asian earthquake in 2005 attracted considerable international donor attention as well as a renewed focus on the part of the government of Pakistan and Pakistani civil society on natural hazards and their impacts on Pakistan's developmental trajectory. All levels of actors involved in the relief and recovery effort have been employing targeted risk reduction measures in their rehabilitation activities. In the Lai basin, following a major flooding event in 2001, the banks of the river were cleared (at least partially) of structures and a flood early warning system was installed with support from the Japanese development cooperation (JICA). In addition, proposals have been floated to construct a major channel capable of diverting all flows into other basins and a major programme for canalisation and conversion of the Lai river bank into a highway has recently been announced.

Our analysis finds that besides the targeted risk reduction measures, there are systemic changes in Kashmir that have a much more profound and sustainable long-term effect on building resilience in the communities. Cellular mobile communication, expansion of financial services, road networks and civil society intervention will not only facilitate recovery but are likely to diversify livelihoods, build social capital and expand opportunities for basic services like health and education. Therefore, activities that are not considered to be part of focused DRR interventions may in fact lead to more sustained DRR, especially if the basis for these systemic changes is led by a business model rather than by policy alone. In Lai, the development policy that is an outcome of competing organisational and sectoral interests relegates DRR to a secondary objective. The resulting risk reduction proposals, despite high initial cost, lack a sustainable business model and are as likely to increase vulnerability as they are to reduce it. Surprisingly, solid waste emerges as the main hazard identified by the majority of the residents surveyed in the Lai Basin. The mortality and disease load from the unhygienic living conditions and contaminated drinking water around the Lai may actually be claiming more lives than the floods.

Technical Description

Hazard / risk type: Flood, earthquake, landslide, water-borne diseases

Muzaffarabad city and the *tehsil* (county) of which the city is the headquarters essentially constitute a narrow river valley formed by the Jehlum and Neelum rivers. Besides the most recent earthquake hazard, historically the district has been exposed to riverine flooding, landslides and to a lesser extent forest fires and droughts. In addition, extreme cold spells in higher altitudes coupled with landslides have been major hazards for the rural inhabitants of the Muzaffarabad Tehsil. Some of the major past disaster events in Muzaffarabad were the great floods of 1992 and periodic slides blocking off the Jehlum and Neelum rivers. The most recent one occurred in 2007. A landslide partially blocked the Jhelum River and in the process killed twenty people in Muzaffarabad Tehsil. Such landslides also disrupt transportation and economic activities, and in the recent case of Jehlum jeopardised the ongoing earthquake recovery efforts.

The Lai Basin drains a total area of 244 km^2 south of the Margalla hills, with 55 per cent of the watershed falling within the Islamabad Capital Territory and the remaining within the downstream Rawalpindi Municipal and Cantonment limits. Islamabad's rapid growth is reducing surface permeability of the watershed, resulting in increased flood peaks downstream. The Lai Basin already receives most (90 %) of its river flows within a period of one and a half months. The current carrying capacity of the Lai is about 10,000 cusecs while the twenty-five year return period flood carries 35,000 cusecs of water causing inundation in the most densely populated areas of Rawalpindi. Climate change predictions of higher intensity storm events would exacerbate this situation. Similarly, Islamabad is in an accelerated process of developing new sectors in the upstream watershed, further reducing its absorption capacity. The combination of these factors is expected to significantly increase the flood peaks in the Lai. Population and economic growth along with the elitist planning of Islamabad is forcing the poorer population of the conurbation to inhabit the risk prone banks of the Lai, particularly because of its proximity to economic opportunities. Again, it is solid waste that has been identified as the main hazard by the majority of residents surveyed. This may be a more serious issue in terms of loss of life than the floods.

- Type of assessment: Research on Disaster Risk Reduction (DRR) and Climate Adaptation Strategies

Contextual Notes

- In both field study sites there are two different types of historical and contemporaneous conflicts. In the case of the Rawalpindi / Islamabad conurbation there has been jurisdictional and institutional conflict between upstream federal level institutions and downstream provincial and local institutions. In the case of Muzaffarabad there is the decades old conflict over sovereignty of the area between Pakistan and India leading to three wars between the now nuclear armed rivals. The most recent low intensity military conflict in Kashmir between the two countries lasted almost two decades, between 1986 and 2005.

- Role of displacement / relocation: The South Asia earthquake displaced millions of people and destroyed many settlements completely. There is a flux of internally displaced people within Pakistani administered Kashmir and in neighbouring Pakistan. While many who could afford it have migrated to other parts of Pakistan, the psychological trauma of involuntary migration and loss of place-based social networks continues to handicap even the relatively better-off migrants from staging a full recovery. In the Lai flood plain at least 19,000 households lie within the historic 100-year return flood plain with most of them having a tenuous legal status over their habitation. Any effective risk mitigation programme will have to include dignified and equitable arrangements for adaptation and rehabilitation / resettlement of many of these households.
- In both cases, there is an ongoing risk reduction effort underway. Some of these may have beneficial effects while the sustainability and effectiveness of others is questionable. In the case of the Kashmir earthquake, for example, the Pakistani authorities are putting excessive reliance on centralised decision making and standardised reconstruction protocols, which are often economically, culturally and socially inappropriate. The dominance of the military mindset on the reconstruction process, a reactive versus proactive and technocratic versus a mix of both technical and institutional approaches is a major challenge in the Kashmir context. Many of the same challenges also continue to haunt the disaster risk reduction initiatives in the Lai Basin. The military government of Pakistan has announced two of the most expensive public works projects in the history of Pakistan in the Lai Basin. The proposed construction of the Pakistan Army's General Headquarters (GHQ) in the headwaters of the Lai without any consideration for the increased flood peaks that may be induce in downstream Rawalpindi is one such example of the short-sighted action. The proposed channelisation of the Lai and construction of an expressway along its bank with DRR as a partial justification in addition to development work is another example of a strategy that is likely to be ineffective at best and perhaps even counterproductive in the long run.
- There are significant historical, geographic, economic, political, or cultural issues that influenced the use of Community Vulnerability Analysis (CVA). The Muzaffarabad case study was undertaken in the context of the largest calamity and relief effort in the history of Pakistan. The Lai research was undertaken over a longer period before and after a major flooding event in 2001.

Research and Analytical Process:

- Methods / tools used: Shared learning dialogues, questionnaire surveys, secondary data analyses and literature reviews.
- Role of climate information. Climate scenarios were discussed with both communities and institutional actors. In both cases the likely climate change scenarios would increase the intensity and frequency of multiple hazards that both areas already face.

Key Insights Generated for Vulnerability Reduction and Capacity Enhancement:

- Direct support to DRR and adaptation: In Muzzafarabad the three main DRR interventions are seismic proof building design, training of masons and training of communities in rescues and relief. All three are useful but their sustainability is not ensured. Having only two housing designs (one conventional brick and mortar design and one for high altitude with local materials) is too restrictive. It is also not clear if the trainings of masons and communities will continue in the future.
- In the Lai Basin, DRR constitutes mega projects, which include diversion of half the tributaries and paving the banks with a two-lane expressway after channelising the river. The economic, social and environmental costs of these measures are very high and it is unclear how building a road along the river is going to reduce flooding.
- At the systems level a sea change of physical and social infrastructures has taken place in Muzaffarabad. Mobile phone and financial services are interventions that would bring long-term resilience and have good sustainability because they have a viable business model. The influx of a diverse institutional relief effort has supported the creation of social capital and better roads have increased access to health education as well as opportunities for more diversified livelihoods.
- The mega-projects in Lai do not address the wider underlying systemic causes of vulnerability. Despite being only a few kilometres from the capital, clean drinking water, sanitation and access to health and transport are some of the most important problems that the communities, especially women, have identified and have even ranked above the floods in some instances.

Potential Strategies Identified:

In Muzaffarabad it is clear that the biggest return in terms of risk reduction and building resilience comes from changes to the supporting systemic infrastructure and that very little can be sustainably achieved from direct DRR interventions.

Focus on large infrastructure based measures is very expensive. One needs to evaluate a menu of structural and non-structural measures. Within the size of planned investments, a wide range of solutions becomes affordable. However, competing organisational mandates tend be affecting policies with lesser emphasis on the cost effectiveness of DRR.

Strategic Notes and Lessons Learned–Key Points to Emphasise:

Systemic resilience is as important, if not more so, than targeted DRR interventions. Such changes, with a good business model, make them very sustainable. Policy driven initiatives within the broader development practice may give DRR second place when organisations compete for resources. In addition, sustainability is limited if mechanisms for maintenance are not well designed.

Keywords: Disaster Risk Reduction, urban hazards, flood hazards, mountain hazards, earthquake

Resource person(s): Fawad Khan (fkhan@isetpk.org) and Daanish Mustafa (daanish.mustafa@kcl.ac.uk)

Introduction

In spite of being the seventh most populous country in the world Pakistan has not been able to muster much international scholarly attention towards its galaxy of human-environment interactions related issues.

MAP 1 | Azad Kashmir and the earthquake affected areas

Data Source: Suparco, UN Cartographic Section, FRC

Two contrasting cases are reviewed in this paper, namely, Muzaffarabad earthquake affected areas and the Lai Basin[1] in Rawalpindi. While the primary hazards in case areas vary in natural causes, frequency and intensity, the comparison between disaster risk reduction (DRR) approaches and their likely outcomes constitutes a greater challenge. In Muzaffarabad the targeted DRR interventions are not likely to have far-reaching impact, whereas the systemic change in the underlying supporting environment, which is rooted in the private sector rather than being policy driven, will potentially have very far-reaching and sustainable DRR impacts. The Lai basin, on the other hand, represents a case where very costly risk reduction measures are proposed and under implementation, however, but both their effectiveness and sustainability are doubtful.

The catastrophic South Asian earthquake of October 2005 attracted considerable international donor attention as well as a renewed focus on part of the government of Pakistan and Pakistani civil society on natural hazards and their impact on Pakistan's developmental trajectory. Muzaffarabad, the capital of Pakistani administered Kashmir, and its adjoining rural areas were hardest hit by the October 2005 earthquake (Map 1). Being located in one of the most highly militarised zones in the world the area had been cloaked in a thick cover of secrecy as far as the outside world was concerned. While the earthquake was a case of incredible human suffering, the sheer scale of the crisis forced the government of Pakistan to open up this inaccessible area to national and international donors, civil society and governmental actors to facilitate relief and reconstruction.

[1] This spelling comes closest to the phonetic pronunciation of the name and is most widely used. Other spellings, e.g., Leh and Lei are also in use.

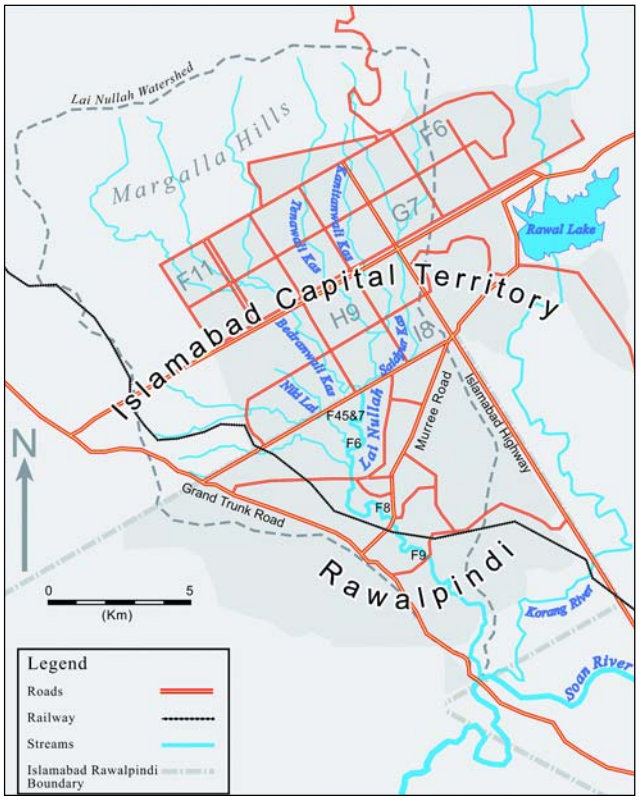
The Muzaffarabad earthquake and its aftermath has laid open a society that had been largely insulated from the outside world providing opportunities for forensic examination of existing relationships and changing them to reduce vulnerability and exposing its pains.

The other hazardscape of Pakistan provides insights into a much slower process of change. The Lai Basin in the Rawalpindi-Islamabad conurbation offers important lessons about the geography of exposure and vulnerability to flood hazard (Map 2). Lai's story could be found in almost any metropolis in the developing world including South Asia. At its heart is a growing urban poor population in a growing economy that is (mis)managed by institutional structures incompatible with the social and spatial realities. The Lai hazard has strong natural and social dimensions. On the one hand, Islamabad, the rapidly growing planned capital city of Pakistan in the upper reaches of the Lai watershed, is reducing surface permeability resulting in increased flood peaks downstream. On the otherhand, climate change forecasts predict a greater number of intense precipitation events during the monsoon season when the Lai River carries most of its flow. Population and economic growth along with the elitist planning of Islamabad is forcing the poorer population of the conurbation to inhabit the risk prone banks of Lai, particularly because of its proximity to economic opportunities. This study therefore responds to the demand for urgent research and generation of knowledge on the hazard-society interface in the context of international donors and development agencies investing sizeable resources in the many complex recovery and reconstruction operations across the globe.

In the following sections we briefly outline the conceptual approach based on a literature review driving the analyses, followed by brief descriptions of the case study sites, major environmental hazards affecting the study area, particularly in the context of global climate change. Having set up the context, the case study sets the general vulnerability profile of the study areas along with a detailed discussion of the methodology used to arrive at that profile. Emerging from the discussion of the vulnerability profile and the methodology are the main points of leverage and possible disaster risk reduction measures that could fruitfully be used in the context of Muzaffarabad Tehsil (county) and Lai Flood Basin in particular, and other risk prone areas in general. The penultimate and concluding sections of the case study offers some reflections on the process and methodology of the case study and some concluding thoughts respectively.

Institutional structures are incompatible with the geographical and spatial realities of the Lai Basin.

MAP 2 | Rawalpindi Islamabad conurbation and the Lai watershed



Conceptual Approach

Different stakeholders within a hazardscape have varying levels of social power and there is often a clash of ideas between them.

The case study draws its intellectual capital from the hazards research tradition within human geography. The research tradition moves away from a focus on physical extremes and defines them as phenomena arising at the confluence of physical extremes and vulnerable human populations (Mustafa, 1998). This approach within human geography pioneered by the American geographer Gilbert White and his students has spawned multiple intellectual perspectives to engage with hazards. The human ecological tradition that White came to be most closely associated with, posits that beyond engineering approaches to controlling the impact of physical extremes attention must be paid to the role of perception in influencing individual and collective behaviour to hazards (White, 1945; Kates and Burton, 1986; Whyte, 1986). Human ecologists are further concerned about the role of perceptions in limiting the theoretically infinite range of choice and propose that scientific inquiry and democratic debates are the key to expanding the 'practical range of choice' in the face of hazards (Wescoat, 1987; 1992).

Hazards researchers have further moved on to focus on socially determined vulnerability as a key variable affecting the distribution and intensity of loss suffered by hazards victims. Researchers within this tradition have been concerned with the political economic contexts that define differential vulnerability (Watts, 1983; Wisner, 1993; Blaikie *et. al.*, 1994; Mustafa, 1998, 2002; Pelling, 2003b). Vulnerability here is understood to be susceptibility to suffer damage from environmental extremes and the relative inability to recover from the damage.

The conceptual approach of this case study combines the insights of the two hazards research traditions within human geography described above and uses the integrative concept of a 'hazardscape' to apprehend the complexities of vulnerability, disaster response and recovery. The term hazardscape as proposed by Mustafa (2005) suggests that vulnerability profiles and what is done to mitigate hazards in specific geographic localities are the outcome of the various stakeholders' perceptions regarding the root causes of disasters and their cultural and institutional biases on what to do about them. Different stakeholders within a hazardscape have varying levels of social power and clash of ideas between them spawn the material configuration of hazardscape. This perspective highlights the importance of perceptions of all stakeholders and how varying social power of stakeholders can create obstacles and opportunities for social actors to pursue policy level and community level interventions. In other words, the points of leverage for reducing risk and vulnerability or encouraging adaptation to changing hazard conditions including those imposed by climate change. This conceptual approach points toward the need for shared learning processes in order to bridge the perceptual, political

and other gaps among stakeholders. In this case, we have approached the challenge of developing shared, reflexive learning processes through the use of Shared Learning Dialogues (SLDs) to facilitate a two way flow of information between the researchers and research subjects to understand each others' perspectives.

Topically the case study and the methodology used were driven by a concern with clarification of the increasingly used concept of DRR, perceptions of DRR amongst different stakeholders, its operational implications and its potentially unique policy implications for development in general. Within human geography much of what is considered to be within the ambit of DRR in the policy circles is called vulnerability mitigation. Vulnerability mitigation as discussed by assorted hazards researchers (e.g., Blaikie *et. al.*, 1994; Hewitt, 1997; Wisner, 2003; Mustafa, 2005) may involve the same suite of policy interventions in various sectors as DRR. In the following case study much of the methodological and vulnerability discussions will be informed by the above conceptual approach.

Shared Learning Dialogue and Cognate Methodologies

SLDs are meant for exchange of information rather than extracting it.

A series of SLDs were undertaken based on a stakeholder analysis by the partners in DfID funded research on disaster risk reduction in South Asia in 2006. Key representatives of the organisations involved with disaster response, management and wider developmental efforts in Pakistan in general and with the field site in particular were consulted. The insights are arranged under the three sub-heads of government, non-governmental organisations (NGOs), and national and international donor agencies. In the latter part of the narrative the organisations and the outcomes of the interviews with their representatives are woven together with the key overarching themes that emerged from the SLDs and the interviews.

SLDs were also used as the basic research tool in communities. ISET and its partners developed a semi-structured interview format for exchanging information and insights with local groups. It was translated into Urdu by PIEDAR and pre-tested with several inhabitants interviewed in the streets of Rawalpindi by the Field Team Leader under the observation of an ISET Research Associate. Later it was used by each of the enumerators on other trial audiences under the observation of the Field Team Leader. Two field sites were chosen and SLDs took place in Jhanda Chaichi and Aarya Mohalla along the Lai. The purpose of the SLDs was to initiate a longer-term research and sharing agenda and also to validate the findings of the earlier research conducted a few years after the major flood of 2001.

At the time of writing, only one round of SLDs has been completed and the real benefits or costs of the SLD process itself and the implementation strategies it was used to identify need to be assessed after a few more rounds. The methodology for the vulnerability analysis consisted of a series of SLDs but we confronted considerable difficulty in implementing it at the field level while experiencing more success in policy level SLDs guided by higher-level staff.

Where the field level was concerned, training workshops and detailed discussions were held with the field study teams to sensitise them to the ethos and techniques involved in conducting successful SLDs. Some of the salient points were the following:

- SLDs are meant for exchange of information rather than extracting it.
- The field team must operate within a non-hierarchical structure with open channels for articulating dissent and clarifying information.
- Field teams must not passively depend upon the more specialised topical specialists to hand them down information, or worse orders to be implemented and / or used as guidelines. Instead, the field teams should be active learners engaged in constant communication with the topical specialists in addition to reading and researching the issues of concern for the SLDs.
- Communities and the institution based research subjects must be approached in a spirit of mutual

respect for their subjectivity and in a spirit of learning as well as sharing information.

- Contextual local knowledge can be enriched with expert knowledge and vice-versa. Neither type of knowledge must be reified. SLDs should be directed towards achieving such a balance.
- The interaction between local and expert knowledge could and should yield actionable suggestions, in our case–for mitigating vulnerability, identifying institutional, cultural, and social points of leverage for policy interventions and for clarifying the social and perhaps even economic benefits and costs of different courses of action.
- The implementation of SLDs must be thoroughly documented without filtering information or various steps in conducting fieldwork.

Despite our efforts, the first round of SLDs were more of classic focus groups with the field team interacting with the research subjects in an extractive mode rather than an information sharing mode. The field reports also lacked in the type of richness and nuance expected from SLDs. In terms of the expectations from the team, the SLDs were conceptualised with the understanding that they would be implemented by individuals with substantial exposure to the core concepts of hazards and vulnerability. In addition, as with most processes for community-based development, the ability to listen to and respect perspectives emerging from different populations (from local villagers to policy makers) was assumed. Finding staff with such capabilities proved difficult.

The key insight on SLDs was that its success and failure, like most things in life depends upon who is doing it. Perhaps the methodology is best implemented by more highly trained people than the field team members. In fact, perhaps even the field team model is not suitable for implementing SLDs – the process cannot be delegated down by researchers. The researchers with a view of the research problem and its context ought to be doing it themselves.

In the absence of results of expected quality from the SLD process greater reliance, in the context of the Lai Basin, had to be placed on data collected by other means in the basin. The methodology was based on household level interviews of residents that are affected by the Lai floods and other issues. A few community group dialogues to share information and triangulate the results complemented this. A household-level survey of 158 households and businesses was conducted in the Lai Basin during the summer of 2002. The review of documents and interviews with policymakers was undertaken in the summer of 2003

In the former part of the research availability of financial and human resources was the main limiting factor in the number of household questionnaires administered. Eighty per cent of the respondents were from the Rawalpindi Municipal area, and 85 of the total respondents were women. The sampling frame for the research constituted the approximately 20,000 households in the flood plain of the Lai (JICA, 2002). The sampling technique was based on convenience sampling with the willingness of the potential

Contextual local knowledge can be enriched with expert knowledge and vice-versa.

interviewees to be included in the survey as the key deciding factor.

Furthermore, geographical spread of the respondents was also a very critical factor. A minimum of five questionnaires was administered in all the major flood affected neighborhoods of the twin cities. The survey results therefore represent a diversity of neighborhoods from the head reaches of the watershed down to the tail end. Referrals from people already included in the survey in the pattern of snowball sampling within neighborhoods were also used to identify potential survey respondents.

Group meetings were meant to triangulate the findings of the questionnaire survey and provide an opportunity for the participants to collectively reflect on their experiences as well as brainstrom on possible solutions to the problems associated with the Lai.

The interviews were conducted by both the researchers and two hired enumerators, one male and one female, who were locals of the city of Rawalpindi. The interviews generally took between half an hour and two hours depending on the level of engagement that the interviewee wanted to have. Although, the questionnaires were used to structure the conversations and to prompt the respondents, the survey participants were at liberty to explore and discuss linkages that they deemed relevant.

Five group meetings in the Lai Basin complemented the questionnaire survey. The group meetings were held in the neighborhoods of Khayaban-e-Sir Syed, Gharibabad, Safdarabad, and Katarian and lasted up to three hours. The group meetings were meant to triangulate the findings of the questionnaire survey and provide an opportunity to the participants of the group meetings to collectively reflect on their experiences as well as brainstorm on possible solutions to the problems associated with the Lai. The meeting in Safdarabad had 20 female and two males, the others meetings had between 10 and 15 participants with the third of the participants being females. Facilitators worked with some small groups on priority ranking of community problems and potential solutions. The questionnaire sought basic household information from the respondents and the damage they suffered in the 2001 floods. In addition, we sought information regarding the sources and type of relief and recovery aid received, their perception of the required types of relief and recovery aid, their expectations of help from various institutions in future disasters, descriptions of the government's role in managing flood hazard, and the actions they have taken to prevent against damage from future flooding.

Muzaffarabad Case Study

Background

Azad Kashmir is one of the most highly militarised regions in the world defining a major international political fault line between India and Pakistan.

The city of Muzaffarabad is the capital of the Pakistani Administered Kashmir, better known in Pakistan as Azad (free) Jammu and Kashmir (AJK) (Map 1).[2] It is a mountainous city at the confluence of the rivers Jehlum and Neelam (also known as Kishen Ganga in the Indian administered Kashmir). Azad Kashmir is one of the most highly militarised regions in the world defining a major international political fault line between India and Pakistan. Kashmir, in effect, is a part of an unfinished agenda of the independence of the Indian Subcontinent in 1947. The dispute over ownership of the territory of Kashmir between India and Pakistan has led to three full-scale wars and a limited war in 1999 in Kargil and numerous other smaller and proxy wars along the Line of Control (Butalia, 2005).

The division of India in 1947 was based on areas under direct British rule. Semi-independent princely states within British India were, however, not part of the scheme and their rulers were free to join one dominion or the other, i.e. India or Pakistan. Kashmir had a Muslim majority populace but a Hindu ruler who, under pressure from invading Pakistani tribesmen, decided to sign the instrument of accession to the state of India against the likely wishes of his Muslim subjects. Pakistan and India both fought a war in 1948 over the territory culminating in the UN Security Council Resolution on August 13th, 1948 ordering a ceasefire for immediate cessation of hostilities and separating the combatants by a Cease Fire Line, which was later converted into the Line of Control. The resolution also recognised the right of self-determination of Kashmiri people through a plebiscite under the supervision of international observers (Lamb, 1991). Such a plebiscite was never held. Pakistan and India continue to administer their respective parts of Kashmir to the west and east of the Line of Control (Map 1).

The AJK region is of particular interest because of the catastrophic earthquake of October 8th, 2005, and the largest relief, recovery and reconstruction operations in the history of South Asia in the earthquake's aftermath. Multiple actors from the most powerful, e.g., the Pakistani military, the military dominated Earthquake Reconstruction and Rehabilitation Authority (ERRA), international donors and the United Nations System, to the less influential Government of AJK and a host of national and international NGOs and civil society groups have been at play with their competing visions, strategies, institutional cultures, epistemic perspectives and resources in the reconstruction and rehabilitation process. The case study draws on the ongoing experience of disaster recovery

[2] We will refer to the region as Azad Kashmir for the sake of convenience and since that is the official name of the region. The use of the nomenclature must not be interpreted as affirmation of any allegiance to the Pakistani position on the Kashmir dispute.

Farmers in Muzaffarabad City

Remittances are an important source of income and account for approximately one quarter of household consumption expenditure in AJK.

and reconstruction to draw lessons about DRR with reference to a wider suite of environmental hazards in a climate change future.

The total population of AJK, according to the 1998 Census is 2.97 million and the Planning and Development Department of Azad Kashmir estimated the population in 2002 to be 3.27 million with a gender ratio of 101 males against 100 females. In terms of religion 99% of the population is Muslim. The literacy rate has been reported at 55% in 1998 Census but estimated to be 60% in 2002 by Planning and Development Department sources. The average annual household income was estimated at Rs. 101,900 (US $ 1676.5).[3] All these figures except average household incomes and literacy rates are similar to Pakistan's average, however, geographically contiguous North Western Frontier Province (NWFP) is somewhat less developed than Kashmir and also lags in gender parity. Pakistan's average household income is about Rs. 80,000 per annum according to PIHS (2002), which is 20% lesser than AJK's.

Total area under cultivation in Azad Kashmir is roughly 170,787 hectares, about 12.8% of the total area of the state. According to the agricultural census of 1990, the average farm size in Azad Kashmir is only 1.2 hectare, half of which is generally cultivated. The area under fruit cultivation is around 14,460 hectares while the area controlled by the Forest Department is the Planning and Development about

[3] Based on a conversion rate of US $ 1 = PKRs 60.78.

566,969 hectares, 42.6% of the total geographical area. Gradually the industrial base in Azad Kashmir is growing as 915 industrial units of different scales are in place which includes textile mills, paper mills, food production units, steel mills and flour mills (personal communication, Planning and Development Department of Azad Kashmir, 2002).

In terms of livelihood, remittances are an important source of income and account for approximately one quarter of household consumption expenditure in AJK. For most recipients, remittances are a primary source of income and in many cases the only source. In Azad Kashmir, remittances to households account on average for 25.1% of total households' monthly income (HPG, 2006). Out migration of men to cities mainly for casual work and menial jobs especially during winter is very common in Azad Kashmir. According to the Prime Minister's Secretariat of Azad Jammu and Kashmir around 200,000 Kashmiris work in the Middle East, while about 500,000 people, particularly from Mirpur and Kotli districts, are settled in the United Kingdom or elsewhere (South Asia Disaster Report, 2005).

In terms of access to services in AJK, the percentage of the population provided with piped water facility is 77% in urban and 62% in rural areas respectively. Apart from urban areas, 88% villages have been electrified. Health sector gives a dismal picture though as the ratio of doctors per thousand population of only 0.1 indicates.

Although AJK is considered to be politically, constitutionally and geographically a separate state, Government of Pakistan (GoP) maintains a strong administrative and military control over the state. Azad Kashmir's foreign policy, defense and currency are under the direct control of Pakistan. AJK Council, an appointed supreme administrative body with a singular majority representation from the government of AJK, manages financial matters (budgeting and taxation affairs) for the state instead of the Central Board of Revenue of Pakistan. Given the military sensitivity of the area, the Pakistani military, however, continues to be the strongest actor in AJK. The traditionally strong role of the military in most spheres of public life within AJK has been further reinforced by the semi-military nature of the GoP since 1999. The defense driven insulation of the area from the influence of national and international civil society actors, NGOs, telecommunications companies (the Pakistan Army's Special Communications Organisation (SCO) being the telecommunications monopoly in AJK) was to have adverse consequences for the relief and recovery operations in the aftermath of the biggest disaster in South Asia.

Around 200,000 Kashmiris work in the Middle East, while about 500,000 people, particularly from Mirpur and Kotli districts, are settled in the United Kingdom or elsewhere.

Natural and Climate Hazards

Muzaffarabad city and the *tehsil* of which the city is the headquarters essentially constitute a narrow river valley formed by Jehlum and Neelum rivers. Besides the most recent earthquake hazard, historically the district has been exposed to riverine flooding, land slides and to a lesser extent forest fires and droughts. In addition extreme cold spells in higher altitudes coupled with landslides have been major hazards for the rural

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View of Muzaffarabad City

Rain induced landslides are further accentuated by the deforested and denuded hill sides where it is not unusual to see houses and communities perched on what seem like impossibly steep slopes.

inhabitants of the Muzaffarabad Tehsil. Some of the major past disaster events in Muzaffarabad were the great floods of 1992 and periodic slides blocking off Jehlum and Neelum rivers. The most recent one occurred in 2007. A landslide partially blocked the Jhelum River and in the process caused death of twenty people in Muzaffarabad Tehsil. Such landslide also disrupts transportation and economic activities, and in the recent case of Jehlum jeopardised the ongoing recovery efforts.

Of the climatically driven hazards, floods and extreme rains have historically caused the most damage. Although, usual monsoonal flooding does cause inundation damage periodically to low lying parts of Muzaffarabad city, it rarely inundates rural Muzaffarabad, where because of the paucity of flat land there is an inverse relationship between the relative affluence of a community and its altitude. The high altitude communities do, however, suffer frequent loss of life because of people getting swept away by swollen mountain streams as they try to cross them on their way to and from low lying market towns, or other villages. Very few of the numerous mountain streams have bridges built on them, and even when present, they are not safe or well maintained.

One of the more dramatic consequences of extreme rainfall event is mass wasting they trigger. The landslides in extreme circumstances can directly sweep away houses and communities but more often isolates remote communities from supplies, educational institutions and medical facilities located in the market towns. This last consequence is particularly important for pregnant women where inability to access medical services during deliveries may contribute to high mortality rates. Our SLDs with the communities confirmed this fact, as they too perceived landslides as the greatest concern. The rain induced landslide is further accentuated by the deforested and denuded hillsides, where it is not

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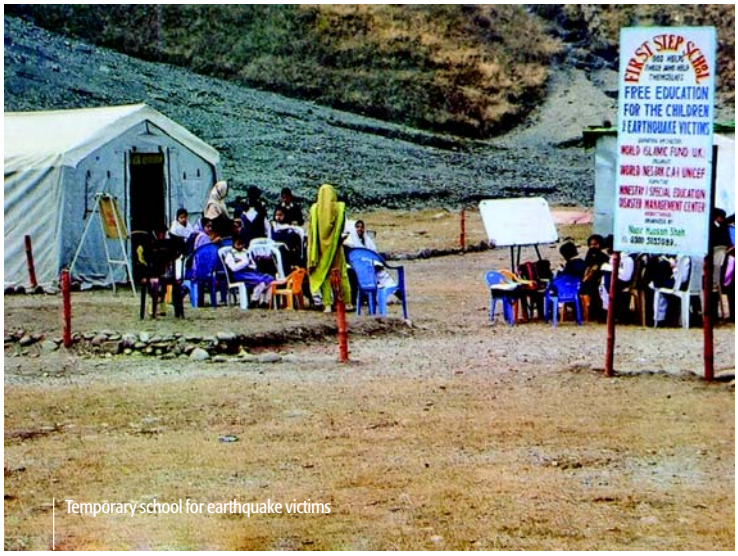
Traditional transport in AJK

unusual to see houses and communities perched on what seem like impossibly steep slopes. Higher than usual snowfall in the Muzaffarabad Tehsil during winters often leads to impacts similar to extreme rainfall events of the monsoon. Communities can often be cut off from the rest of the world with serious consequences, again particularly for pregnant women, the sick, the elderly and the children.

In addition to the above major hazards, forest fires in some remote higher altitude forests are part of the forest regeneration cycle in the area. Because of relatively higher population densities and at times overgrazing of forest floors there is just not enough fuel for forest fires left in locations closer to human habitations. But forest fires in more remote locations do cause damage to the shelters of migrant goat herder (Gujjars). Occasionally forest fires can come close to some market towns and cause damage in some secondary market towns of AJK.



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Temporary school for earthquake victims

Patterns of Vulnerability

The patterns of vulnerability to the hazards discussed above can partially be surmised from the damage figures of the 2005 earthquake. Similar patterns of vulnerability are present in relation to most hazards. A brief review of the earthquake damage figures will illustrate the point about the differential vulnerability of the women, children and the elderly. Numbers indicate that urban population was particularly vulnerable to the earthquake. The common rounded stone or brick masonry with weak mortar and no seismic detailing could not withstand the earthquake. Anecdotal evidence also suggests issues in construction quality and standards whereby 17,000 school buildings and hospitals made by the government collapsed killing many children (EERI, 2006).

The damage figures for the earthquake are revealing in terms of what they do not have. We searched at length for the fatality, and major and minor injury figures disaggregated by gender by the 2005 earthquake. We found that the lead agency for the earthquake relief and reconstruction, with supposedly the best access to data did not have gender disaggregated numbers. This limitation is partially because concern of the lead agency was with aggregate numbers with respect to the compensation owed to the families. The AJK Government had announced a certain amount of compensation for those who had suffered a death in the family as a result of the earthquake or had suffered an injury.

The government was evidently not concerned whether the victim was man,

The government has not tallied data on casualties from the earthquake by gender and/or age revealing a lack of concern with these as a drivers of vulnerability in post disaster planning and programming.

woman or a child, it just wanted to know how many dead and injured and hence how much it owed. The government has not tallied the aggregate data by gender and or age revealing a lack of concern with age and gender as a driver of vulnerability in post disaster planning and programming. This institutional invisibility of women, children and the elderly, let alone by class / caste, e.g., the lower class Gujjars versus higher class Rajput could, in reality, be a driver of vulnerability.

FIGURE 1 | Fatalities by gender and age group

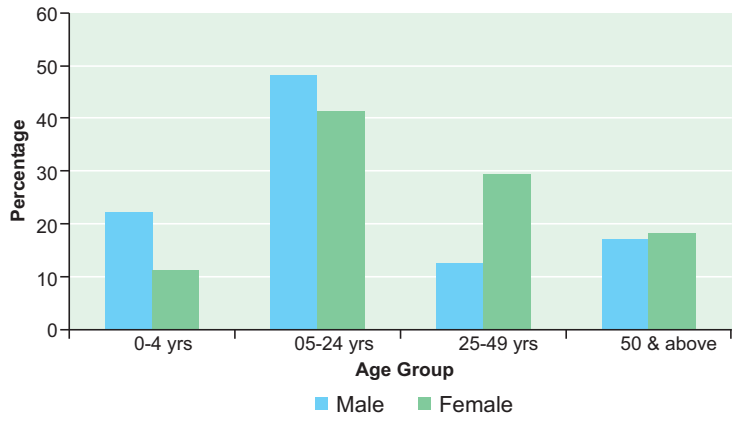
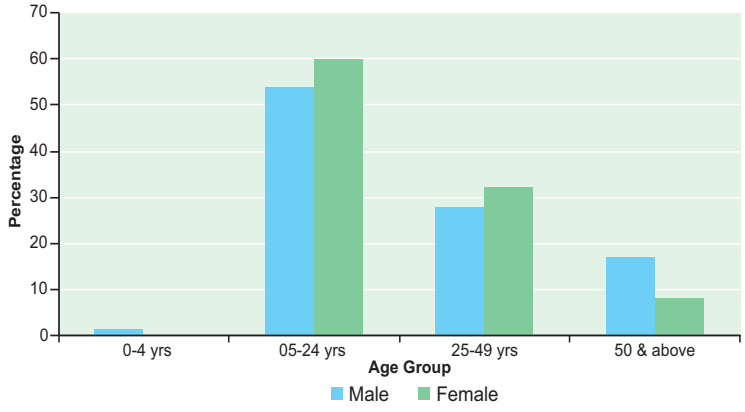


FIGURE 2 | Serious injuries disaggregated by gender and age



Some non-governmental organisations did, however, undertake spot surveys based on large enough samples, with sufficient randomness and geographical coverage that could be used to project the proportions of earthquake victims by gender and age. One such random survey of refugee population in camps all over the earthquake affected areas was conducted by the 'Center for Research on Poverty Reduction and Income Distribution' (CRPRID, 2006)[4], a semi-governmental research organisation. Based on the study one can make following observations about the pattern of vulnerability during the earthquake.

Overall number of males and females among killed were almost the same (male 51%, female 49%). There was substantially higher proportion of males (64%) among the seriously injured, though females (53%) had a higher proportion among those with minor injuries. When disaggregated by age, the pattern of vulnerability by gender starts falling into a sharp relief. Figure 1 presents the fatalities figures disaggregated by gender and age. More to the point and somewhat mysteriously[5], among pre-school children 68% of the fatalities were male. Among the school and college going children and young adults in ages between 5-24 years, 55% of the fatalities were male, perhaps indicating a higher proportion of male enrollment in schools. Incidentally casualties were higher because school buildings had collapsed. In the married and

[4] They used a much more liberal definition of a camp than the government-they defined any group of ten or more tents as a camp, which is more liberal than the threshold of 40 that the government used to define a camp.

[5] Male births and deaths are generally documented more readily than in case of women. This sometimes attributed to the patriarchal systems that determine inheritance and common property rights by the number of male family members.

productive age group of 25-49 years of age an overwhelming 69% of the fatalities were female. This figure indicates the gender roles within the society that keep women limited to indoor domestic tasks and hence more exposed to building collapse. This observation is also confirmed by Mahmood (2007) who reports that of the 252,073 individuals surveyed by Population Council in assorted refugee camps in the earthquake zone 53% of the orphans had lost their mothers, as opposed to 43% who had lost their fathers and 4% who had lost both their parents. And finally an equal proportion of home bound males and females among the middle age and senior citizen community were dead. The elderly did, however, suffer disproportionately–more than twice as much as their numbers in the population. According to Mahmood (2007) people above the age of 50 constituted no more than 9% of the population in the earthquake affected area.

On the serious injury side, however, the proportions are almost equal between males and females across all age groups except among the fifty and above group, where females constitute about 27% of the seriously injured populace. Figure 2 describes the seriously injured populace disaggregated by gender and age. There are no observations to report in the 0-04 year category, possibly because of the lower survivability of this age group and probably also because fatalities were under reported. Overall among the females the age group straddling the married and school going age (5-24 years) had the highest serious injury rate. This high injury rate could partially be a function of the higher survivability of this age group.

The SLDs however, revealed a somewhat different perception of vulnerability on part of the urban and rural communities in Muzaffarabad Tehsil. Both the urban and rural communities reported children as the most vulnerable segment of the population, which at least in the context of the fatalities and serious injuries experienced in the 2005 earthquake is not true. The emotional appeal of children getting hurt perhaps accounted for this perception, and also that many of the traumatised children who reportedly suffered acute symptoms of trauma were a constant reminder to the community of how vulnerable–at least emotionally–that segment of the population was. Only one of the eight groups with which SLDs were held in Muzaffarabad Tehsil–and that too of rural women–thought that women constituted the more vulnerable group. Also, only one of the SLD groups, or urban men reported the elderly to be a noticeably more vulnerable population.

Another group that surprisingly emerged as vulnerable was the middle and lower middle class. Part of this vulnerability was by virtue of the fact that much of the lower middle class has socially moved upwards from a working class based on remittances income. But in the aftermath of the earthquake many of them had to come back to take care of their injured or homeless family members but then could not leave because there was either nobody to take care of the remaining family or because of the extended stay in Pakistan they had lost their overseas jobs as the following comments shows:

> I was working in Saudi Arabia and on hearing the news of the earthquake I rushed back to check on my family

In the married and productive age group of 25-49 years of age an overwhelming 69% of the fatalities were female.

> members. But I cannot go back because I have to care for my elderly parents. I have lost my job and it is hard for me to make ends meet.
>
> (Aslam Kasbi, a Muzaffarabad city SLD participant, April 23rd, 2007)[6]

The lower middle class also emerged attitudinally vulnerable. They did not get access to relief aid as the following quote illustrates:

> We are respectable people. We cannot stand in the queue to get food from the camp. I would prefer it if aid were provided at the ward (neighborhood) level so that everyone could get it in a dignified way.
>
> (Chalu Shah, a Muzaffarabad city SLD participant, April 23rd 2007)

The elderly did, however, suffer disproportionately- more than twice as much as the rest of the population.

This theme of the class relations being reversed recurred many times during the SLDs. Most people perceived that well-off people had turned paupers and poor people had turned affluent in the aftermath of the earthquake. Although, we believe that this perception might be a little exaggerated but there was some truth to the fact that many absolutely poor people, particularly from the highlands had gained access to cash and resources that they had never had in the past while many relatively better off families had lost whatever assets they had. This is not so much a reflection on the efficiency or effectiveness of the relief and rehabilitation process as it is of the social context (desperate poverty) that characterises the area.

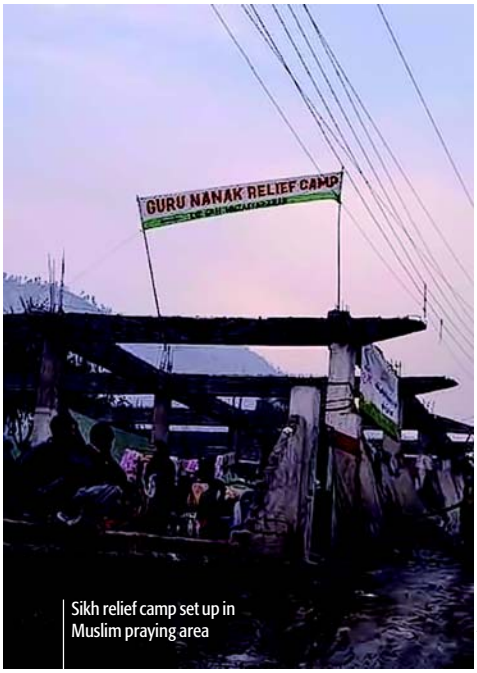
A post-earthquake rapid participatory assessment of AJK by Food and Agriculture Organisation (2005), 20 % of the best-off families receive remittances from members working overseas, sometimes in OPEC countries. Another 40% have jobs in either AJK or Pakistan, mostly Army or Government. And about 40% relied entirely on Agriculture and these were the most affected people because of the damage to land and livestock. Most of these better off people moved down country to Pakistan and 50% of the respondents were seriously considering it. The poorest 10% were 'staying put' and were the most vulnerable among the surveyed population.

Ongoing and Prospective Strategies for DRR

Even with limited understanding of DRR most stakeholders are working towards implementing DRR strategies. Western designed seismic proof building seems to be the top priority. With all the problems of bringing such technology to the area ERRA, which coordinates all the reconstruction activities has mandated that all construction with government funding must follow a single (and then later a second) design. Use of this single design has been very restrictive. Strategies for adoption of the design in longer term have not yet been devised. Moreover, many people in anticipation of a cold winter had already started construction ahead of any instruction from ERRA. Many other organisations, mostly civil society, started DRR with training masons for better construction.

Another common strategy among the NGOs has been training communities in rescue and relief activities. This would help the trained communities in

[6] All names quoted are fictitious to protect the identity of the individuals interviewed.



Sikh relief camp set up in Muslim praying area

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response to a large disaster. Sustainability of this measure has once again not been clearly thought through. Community based, voluntary or semi public rescue systems based on models such as the Edhi foundation need to be devised in the future to make them sustainable and also attend to other more frequent risks such as landslides and floods.

Beyond these very basic responses to risk reduction there was little evidence of other measures for risk-reduction. Just like Lai the lack of financial services were conspicuous by their absence.

The preliminary SLDs conducted in Muzaffarabad and Lai at institutional levels did not show appreciation for many of the underlying systemic factors research suggests contribute both to risk reduction and adaptive capacity. Changes at this level, mostly unintended, have however been massive.

First, the cellular phone companies were for the first time allowed to operate in the area to support the relief activities. Such accessible and affordable communication is immensely useful in early warning and is unparalleled in supporting commercial and social networks, in addition to opening up a previously closed society to diverse experiences. Economic and social diversification is expected to build sustainable resilience where economic diversification was confined by restricted communication justified by security considerations.

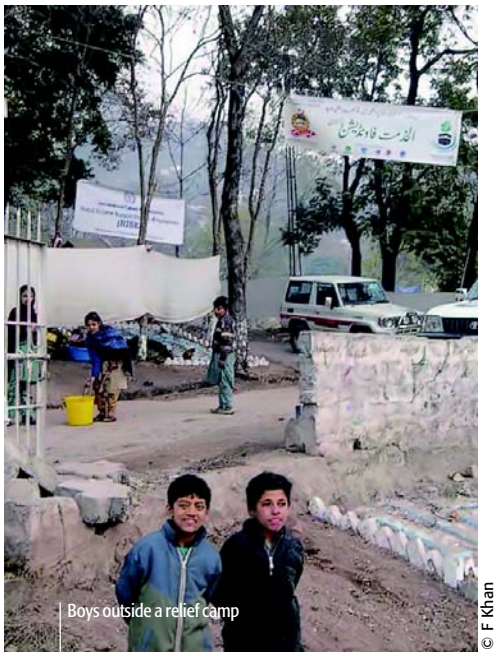
Another significant change in the area was the immediate expansion of formal financial services necessitated by the disbursement of compensation through transparent channels. Identity cards and banks accounts have become ubiquitous in a region where most financial transactions were informal and even the foreign remittance were made through the traditional *'hundi'* system that relied on personal contact and trust, thus limiting its ability to build resilience at scale. This mass enrollment into formal systems can potentially lead to micro-credit and insurance.

Third, due to the scale of the disaster, Muzaffarbad saw one of the largest relief efforts in the history in Pakistan. Scores of aid agencies, multi-national, national and local civil society organisations joined hands with the military in an earnest effort to help the people of AJK (including some that are classified as terrorist organisations by the larger world community). Such institutional diversification was

unprecedented in Kashmir's history. Most relief was provided through concerted effort of the government, civil society and international community through community participation.

Finally, the largest relief effort in Pakistan lead to improvement of the transportation and road networks in Kashmir. Increased accessibility has resulted in economic diversification and probably will have an impact on access to social services. The international relief effort has also increased the provision of these services across AJK.

Conceptually, the strengthening of communications and other systems represents a much larger contribution to DRR and adaptive capacity than the direct measures most organisations classify as DRR.



Boys outside a relief camp

© F Khan

The expansion is likely to contribute substantially to diversification of livelihood systems in the region. The systems are also likely to improve other forms of social capacity that mitigate risks–for example through the role improved communications provides as a basis for social networks. Conceptually, the strengthening of such systems represents a much larger contribution to DRR and adaptive capacity than the direct measures most organisations classify as DRR. Many such systems are self-sustaining. Improvements in communication and financial services, for example, are based on strong business models that are independent of development aid or external support. They were also catalysed more by policy changes and local demand than by direct public sector investment. As a result, the benefits of such systemic improvements for DRR are almost certain to far outweigh the costs.

Lai Flood Basin Case Study

Background

Substantial debates are currently occurring regarding how to reduce the risks associated with flooding in the Lai Basin. Following a major flooding event in 2001, the banks of the river were cleared (at least partially) of structures and a flood early warning system was installed with support from Japanese development cooperation (JICA). In addition, proposals have been floated to construct a major channel capable of diverting all flows into other basins. Cost and opposition from inhabitants in other basins have limited implementation of this. In addition, to these disaster risk specific proposals, a major programme for channelisation and conversion of the Lai riverbed into a highway has recently been announced. This is often portrayed as reducing disaster risk as well as increasing transportation–but the scientific basis for this is questionable. As discussed below, the local perceptions of risk and potential strategies for reducing the hazards associated with flooding only partially match with the proposals currently being floated. If the intensity of extreme climate events increases as projections suggest will occur as climatic conditions change, hazards in the Lai Basin will increase as well.

The Rawalpindi / Islamabad conurbation is the fifth most populous urban area in Pakistan with a combined population of 2.1 million, with 1.5 million of the residents in Rawalpindi and the remaining in Islamabad (GOP 2000). The conurbation is an important economic and transportation node connecting southern and eastern Pakistan with the Northern Areas, Azad Kashmir (Pakistani Administered Kashmir), and the Northwest Frontier Province (NWFP). As the capital of Pakistan, Islamabad has all of the administrative structure of the federal government, while Rawalpindi is the headquarters of the Pakistan Army, the most important institution in Pakistan.

The history of the twin cities offers some interesting comparisons that are relevant to understanding the geography of exposure and vulnerability to flood hazard in the conurbation. In the pre-independence era, Rawalpindi was the headquarters of the British Indian Army's Northern Command, the largest of the British Indian Army Commands in United India. The Pakistan Army inherited the site as its headquarters in the post-independence days. The military dominates the social and economic life in the city, with more than fifty per cent of the jobs being associated directly or indirectly with the armed forces. Overall 64 % of those employed in the city hold jobs in the public sector, 36 % are in the private sector, and 23 % are self-employed (JICA 2003). There are really two cities within the legal boundaries of Rawalpindi city: the Rawalpindi cantonment, administered by the Rawalpindi Cantonment Board (RCB) under the Ministry of Defense, and the city of Rawalpindi, governed by the civilian-elected Tehsil Municipal Administration (TMA). The cantonment lies on a higher ridge on the western edge of the Rawalpindi city and is relatively safe from Lai floods, except in the southern most part of the basin. Rawalpindi city, on the other hand, is

highly exposed to flooding from the Lai Basin. The 100-year flood inundation zone of the Lai is primarily occupied by lower middle-class and working-class neighborhoods.

The Lai Basin drains a total area of 244 km^2 south of the Margalla hills, with 55 % of the watershed falling within the Islamabad Capital Territory and the remaining portion within the downstream Rawalpindi Municipal and Cantonment limits (Map 2). The stream has five major tributaries: Saidpur Kas, Kanitanwali Kas, Tenawali Kas, Bedranwali Kas, and Niki Lai, in addition to twenty other minor tributaries. The maximum length of the Lai from beginning to its final confluence with the Soan River does not exceed 45 km, thereby allowing very little time for any flood warning in its middle reaches within the Rawalpindi municipal limits.

The institutional hazardscape of the Lai is characterised by multiple, fragmented jurisdictions. At the macro-scale, the upper basin is under the federally controlled Capital Development Authority (CDA) and its various directorates, e.g. for water supply, sanitation, and environmental management. The middle basin falls under the Rawalpindi TMA as well as the provincially-controlled Rawalpindi Development Authority (RDA). The lower basin is again under federally controlled Rawalpindi and Chaklala Cantonment Boards (RCB and CCB) and their various departments. The assorted stakeholder institutions within the Lai Basin display all the specialised bureaucratic structures and disciplinary backgrounds, from public administrator to civil engineers, particular to a modernist state apparatus. Where Islamabad's urban geography may be the poster child for the high modernist ideology inherent to 'seeing like a state' (Scott, 1998), the state institutions operating within the Lai Basin also manifest what Dove and Kammen (2001) call disconnect between the fluid and diverse 'vernacular models of development' and the 'official models of development.' Bureaucratic objectives are disconnected and uncoordinated: the Sanitation Directorate of the CDA is preoccupied with solid and liquid waste disposal, while the Relief Commissioner of Rawalpindi focuses solely on floods. The messy interlinkages between issue areas, although widely recognised, do not and supposedly *must* not distract the public servants from their assigned tasks.

The assorted stakeholder institutions within the Lai Basin display all the specialised bureaucratic structures and disciplinary backgrounds, from public administrator to civil engineers, particular to a modernist state apparatus.

Lying upstream, Islamabad is a preplanned modern city. Its grid pattern with wide, tree-lined boulevards and relatively low urban density, presents a sharp contrast to the mostly curving, narrow streets of its older neighbor, Rawalpindi. A Greek architect, Constantinos A. Doxiadis, designed lslamabad and brought many of the principles of modernist-militarist architecture to his design of Islamabad and to the other towns, university campuses, and buildings he planned throughout Pakistan and the rest of the world (Spaulding, 1996). According to Spaulding (1996), Doxiadis was an idealist who planned the city based on his conceptions of what an ideal modern city should look like rather than the material reality of how the urban geography of Islamabad might be experienced and lived by its inhabitants. European concepts of social class and distinctions based on civil service rank are written into the Islamabad Master Plan, and manifest themselves poignantly in the geography of the city (Meier, 1985).[7]

[7] By the European sense we mean the relatively recognizable division of economic classes in the industrialised societies of Europe, e.g., the working class, the petit bourgeoisie, the bourgeoisie, and the ruling classes (Also see Gramsci, 1971)

Idealistic urban planning did not change social and environmental realities, but rather exacerbated them. Doxiadis projected that the lowest ranking government servants would reside in working-class neighborhoods, while the poorest of the poor – garbage collectors, street sweepers, housemaids, beggars, and day laborers – did not figure in Doxiadis' plans. His idealism, played out on sketches, diagrams, and scale models, overlooked the impact that local topography had on the social geography of the absolute poor in the city. It is little surprise, then, that wherever the topography dips below the putative plain of human habitation, by the banks of the tributaries of the Lai, one finds unplanned shantytowns or *katchi abadis* (Spaulding, 1996). More than 3 per cent of the population of Islamabad, about 3,000 households, lives in these *katchi abadis* and they are also the only neighborhoods that repeatedly suffer damage from floods. They were, as a result, especially affected by the 2001 flood event.

Natural and Climate Hazards

Flood hazard in the Lai Basin is endemic for the twin cities. Most recently, the Lai flooded on 24 July 2001, affecting 400,000 residents of the twin cities, mainly people of the poorest class. The death toll from the flood stood at seventy-four, with sixty-four of the total fatalities in the downstream city of Rawalpindi (United Nations Relief Web, 2003). The official estimate for damage from the flood is Rs. 15 billion (approximately US$250million), though unofficial estimates have been as high as Rs. 53 billion (approximately US$930 million)– an enormous sum of money for a country with a total official GDP of US$60.5 billion (JICA, 2003; The World Bank, 2003). In recent years, the Lai also flooded in 1995, 1996, and 1997; these latter calamity caused eighty-four fatalities and destroyed 1,000 houses (NEC, 2002).

The physical location of Islamabad creates special problems for Rawalpindi downstream. Islamabad was designed with very little regard for the hydrology and geomorphology of the basin in which it is located. The decreased water absorption capacity of an expanding Islamabad further accentuates flood peaks downstream, in addition to reducing the ground water recharge upon which much of Rawalpindi's poorer population depends for water supply (Malik, 2000). Clearly, from Doxiadis' reality of a scale model of Islamabad, to the hydrology of the Lai, to the social geography of vulnerability to flood hazard, multiple material and discursive factors go into producing the hazardscape of the watershed of the Lai.

Islamabad was designed with very little regard for the hydrology and geomorphology of the basin in which it is located.

The Lai Basin already receives most (90 %) of its river flows within a period of one and a half month. The current carrying capacity of Lai is about 10,000 cusecs while the twenty-five year return period flood carries 35,000 cusecs of water causing inundation in the most densely populated areas of Rawalpindi. Climate change predictions of increased precipitation on the approximately same number of rainy days – in effect, higher intensity storm events – would exacerbate this situation. Similarly, Islamabad is in an accelerated process of developing new sectors in the upstream watershed reducing its absorption capacity. The mix of these factors is expected to significantly increase the flood peaks in the Lai.

While the policy makers in the Lai are largely focused on the more dramatic flood hazard, the residents of the Lai Basin perceive a range of hazards within the basin. Surprising solid waste emerges as the main hazard identified by the majority of the surveyed residents in the

Lai Basin. The mortality and diseases load from the unhygienic living conditions and contaminated drinking water around the Lai may actually be claiming more lives than the floods. Much of the vulnerability patterns discussed below will be with reference to the multiple hazards within the Lai Basin.

Patterns of Vulnerability

While the policy makers in the Lai are largely focused on the more dramatic flood hazard, the residents of the Lai Basin perceive a range of hazards within the basin.

The average household size of the survey respondents was 7.6, in both extended and nuclear family living situations. The average educational attainment of the most educated person in the survey household was 9 years of schooling with only 11% of the respondents reporting a household member with education beyond the 12-year high school level. The results of the field survey are presented and analysed below with an eye towards drawing lessons for provision of effective relief and recovery, especially along gender lines, in the future.

Of the 158 survey respondents, 90% reported some form of property damage; typically complete loss of household items down to pots and pans, and clothing in the 2001 flood. Forty eight per cent of the respondents also reported structural damage to their houses, while 38% reported loss of livelihood because of a loss of the business establishment where they worked, or loss of draft animals, or the inability to find day labor jobs. The loss of property was generally the more traumatic result of the flood, as some of the following quotes illustrate from the flood victims, when they were asked what measures they were going to take to mitigate the effects of future floods:

> We do not anticipate greater loss in the future because I have lost all I could short of my children and my own life.
>
> **(Ghulam, a male respondent)**

> I have been completely ruined. Nothing is left with me. I sold my shop to get some household items, and now my family is on the brink of starvation. I was asthmatic and now I also have coronary problems.
>
> **(Saleem, a male respondent)**

Remarkably, less than 10% of the respondents reported sickness in the family as a consequences of the floods. When asked about that in a group meeting with the residents of a flood plain neighborhood, the people reported that given the liberal dumping of liquid and solid waste in the Lai Basin, the hygienic situation is such that somebody is always sick in their households, particularly the children from waterborne diseases all year around. Consequently, respondents generally did not ascribe sickness to the specific flood event in 2001. Besides, of the 142 million liters of liquid waste generated by Islamabad and 143 million liters generated by Rawalpindi, 2 only 19 million liters are treated, while the rest finds its way to the Lai untreated (Malik, 2000b; JICA, 2002)[8]. The twin cities generate more than one thousand tons of solid waste per day, 600–700 tons of which is produced by Rawalpindi. In Rawalpindi, the TMA collects only 60% of the trash, the remainder as well as unknown proportion of the collected trash, often finds its way right into the Lai channel (Rawalpindi Development Authority, RDA), 2003; JICA, 2002). It is little wonder then, that 70% of the respondents identified solid waste disposal in the Lai as the most pressing issue with regard to

[8] This is based on 284 l/day/head produced by the half a million residents of Islamabad and 95 l/dayper head of wastewater produced by the 1.5 million residents of Rawalpindi, as reported by Malik, 2000b.

the Lai, while 50% perceived floods as also an important issue.

When the responses were disaggregated by gender, it was found that more than 80% of the women considered solid waste as the most pressing issue, while 70% of the men considered it a pressing issue[9]. More than 25% of the female respondents identified water pollution as a pressing concern while none of the male respondents mentioned it as a concern (Figure 3). Along the same lines, 41% of the female respondents thought that one of the chief benefits of floods in the Lai was the annual cleanup of it, while, only7% of the male respondents could see any benefit to the floods:

> Floods in the Lai annually clean up Rawalpindi and Islamabad, otherwise the trash in the Lai would generate unbearable diseases–clothes would start walking with vermin.
>
> **(Mrs. Ijaz, A female respondent)**

> The damage caused by floods is more visible to the people, but the floods also clean up the Lai, something that the government is not capable of doing.
>
> **(Rabeea, A female respondent)**

However, not everyone saw benefits to flooding in Lai and for the most exposed and vulnerable it was all doom.

> The only benefit of the flood is that it will sweep us away and put us out of our misery.
>
> **(Sadiq Masih, A male respondent)**

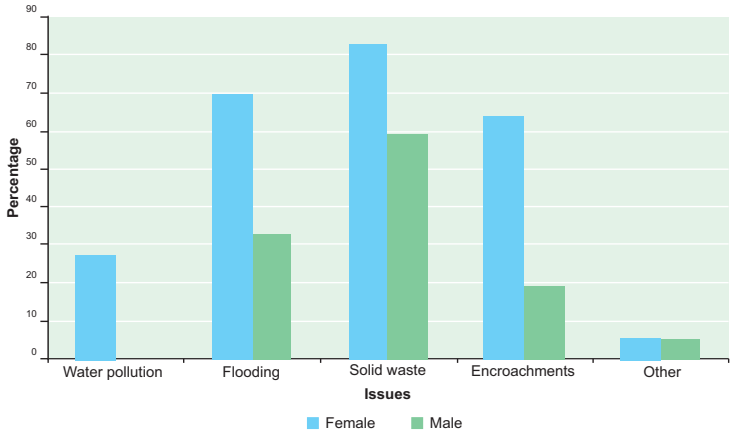
Part of the reason for women's greater attentiveness to the beneficial aspects of floods could be their greater responsibility and engagement with the domestic sphere. Since it was the women who had to spend more time with the health and sanitary hazards of the pollution in the Lai, they were also more concerned about those hazards in addition to the flood hazard. The evidence suggests a strong gender dimension to interaction with the environment, something that could have important ramifications for any community mobilisation initiatives. This was also borne out by the group meetings as discussed later in the chapter.

During the SLD process of 2006, there was no significant change in the views of local respondents from those expressed several years earlier. The population was, if anything, more concerned about the sanitation hazard as a constant threat and also considered earthquakes as additional hazard, which they had not identified earlier.

The dumping of garbage in to Lai Basin was described as the major reason for flooding. The settlements along the stream do not have a proper waste collection system. There are no access roads along the banks for Cantonment Board trucks to move and collect refuse.

Women often saw low levels of flooding as a benefit because it cleaned out the Lai.

FIGURE 3 | Perceived issues with Lai by gender



[9] In each of the categories of responses, the women seemed to be more attentive to the issues with regard to Lai than were the men.


Solid waste and sewage

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In essence the pattern of vulnerability in the Lai Flood Plain is associated with multiple health and physical hazards spawned by environmental, infrastructure related and institutional factors.

As such, all the waste generated in the adjacent settlements is dumped in the channel. After heavy rains, water overflows the channel and worsens the situation on both banks.

The community reported that there is no hospital or even dispensary in Jhanda and Arya Mohalla where the SLDs were conducted. People reported tremendous health hazard associated with lack of easy access to medical facilities. Overall, transport was identified as a key issue often in relation to health care. Because of this, the residents of Jhanda reported that they are having trouble finding spouses for their children. Outsiders consider them unmarriageable because of their poverty and the difficulties of access in their locality.

Another important concern was rain water and floodwaters stagnating in the streets, mostly because solid waste, particularly plastic bags blocking whatever drains that are there. People find it difficult to get to their jobs, businesses, schools, and so on, for sometime after rains and floods. The meeting participants attributed the outbreaks of diseases like malaria, hepatitis and dengue virus in Arya Mohalla to stale rainwater standing in the streets. Effluents were mixing with drinking water through broken pipes. They said that every third person in Arya Mohalla was suffering from hepatitis.

In essence the pattern of vulnerability in the Lai Flood Plain is associated with multiple health and physical hazards spawned by environmental, infrastructure related and institutional factors. Because the basin is home to the capital city of the country and there is some high level attention to the hazards associated with the Lai. The attention, however, does not seem to be promising any sustainable DRR measures that may enhance resilience as we briefly discuss in the following section.

Ongoing and Prospective Strategies for DRR

On March 27, 2007 the president of Pakistan announced the Lai Expressway project as a part of the campaign for elections at the end of the year. The proposal is to build two-lane 22km long expressway on the both banks of the Lai after channelisation and straightening of the banks. Expected to cost approximately 250 million dollars, this project is intended to facilitate the increasing vehicular traffic between Rawalpindi and Islamabad. It will also connect the old General Head Quarter of the Army to the new one in Islamabad. The project is supposed to provide risk reduction through stopping of throwing of garbage into the Lai, faster flow of storm water through paved sections and providing a levee.

The project has been approved by a presidential directive and by-passed all government planning procedures including Environmental Impact Assessments. It has also been awarded to a semi-autonomous military construction company without competition[10]. The same organisation is doing the feasibility study.

[10] The Frontier Works Organisation's claim to fame is its involvement in the making of the Karrakuram Highway that leads to China

The current Lai Channel capacity is around 10,000 cusec and it is unlikely that even after improvement the Lai will contain a 25 year historic return period floods whose magnitude is likely to be 35,000 cusec. Moreover, there are complex issues with channelisation of a river and the costs involved in maintaining such a canal, especially with erosion of the road base during floods. The communities had mentioned the road and its benefit in allowing garbage removal and access, however, it did not come up in the top ten priorities for risk reduction. Also an 'expressway' is unlikely to facilitate non-motorised access to the poor who expressed the need for it during the SLDs.

The decision-making authority is in the hands of the military, which populates the offices of top management in the country. Despite its infancy, the National Disaster Management Agency would be a natural place to start comprehensive risk reduction strategies for emerging hazards with a holistic approach for two reasons. First, the NDMA has a mandate to address cross-jurisdictional and cross-sectoral issues endemic to the Lai. Second, due to NDMA's placement in the Federal Government under the Prime Minister's Secretariat and military leadership it has the clout to bring CDA, RDA and other concerned agencies to the table and make decisions. The military leadership, however, does not have a sound understanding of a proactive approach and is not very receptive to cross-sectoral research and analysis. Also, any initiative that would undermine a project announced by the President is unlikely to find support within any part of the government.

The other direct route once again at the Federal level is to rally political support from the prominent member of national assembly and minister from the area. A presentation given to minister on rehabilitation of the Lai has made him aware of the issues but not to the extent that would cause a major change in the trajectory of the development activities. The minister probably cannot afford opposition from the ruling party and is unwilling to become a spanner in the works by all other mid-level agencies.

A third approach would be to strongly influence public opinion on the subject through education of journalists, vocal NGOs and social activists. This carries the risk of creating an antagonistic rigid stance from the government and also may be detrimental to receptivity to future disaster risk reduction research in Pakistan.

Lai cancelling out river improvement, 2002

Lai cancelling out river improvement, 2007

Institutional SLDs on the Two Case Studies

Disaster management in the Pakistani context has historically been a provincial and a local subject, with logistical and material input coming from the federally controlled armed forces.

The SLDs were conducted by the researchers themselves at the institutional level with key organisations involved in disaster response, management and wider developmental efforts in Pakistan in general and Kashmir region in particular. In this section we outline key insights gained from those meetings and the SLDs. The insights are arranged under the three sub-heads of government, non-governmental organisations (NGOs), and national and international donor agencies. In the following narratives the outcomes of the interviews with their representatives of various organisations are woven together with the key overarching themes that emerged from the SLDs and the interviews.

Federal, Provincial and Local Government Agencies

We contacted representatives of government organisations at the local, provincial and national levels. At the federal level the discussions were held with representatives of the newly formed National Disaster Management Authority (NDMA), Center for Research on Poverty Reduction and Income Distribution (CRPRID) and Earthquake Rehabilitation and Recovery Authority (ERRA). At the local levels we met with the Additional Deputy Commissioner (ADC) Muzaffarabad and Local Government Department, AJK.

Disaster management in the Pakistani context has historically been a provincial and a local subject, with logistical and material input from the federally controlled armed forces typically providing support to the provincial and local authorities. In the aftermath of the unprecedented earthquake in northern Pakistan, the semi-military government of Pakistan has decided to federalise the disaster relief, reconstruction and management functions. NDMA is structured under the prime minister through an ordinance NDMA is meant to play role as the key organisation intended to be responsible for coordinating disaster management in the country while channeling international and national disaster relief and reconstruction resources.

Like many other sectors of Pakistani public life disaster management has recently seen increasing militarisation. Serving (or recently retired) military officers dominate the two key federal level disaster management organisations–NDMA and Earthquake Relief and Rehabilitation Authority (ERRA). The latter just has a titular civilian as its head and that too reportedly because of international donors' insistence upon dealing with a civilian.

In our conversations with the head of the NDMA it came across quite clearly that the General in-charge, consistent with his training, had a very technologically driven, command and control based approach to disaster response. He was clear in expressing

his skepticism about DRR declaring it yet another buzzword, but was compelled to agree to it because of his interaction with international donors supporting almost all of his programmatic activities. Despite frequent probing the general continued to define disaster management in reactive terms, e.g., 'tell me of a specific technology that I can use to make disaster response more effective' (Personal communication, 16 / 12 / 2006). One of his statements was particularly indicative;

> One of my biggest concerns is getting together a set of instructions and metrics for different ministries in terms of disaster management, e.g., the Women's Division and Communications ministry, that I can use as a way of monitoring if they are playing their role in disaster management and prevention.

The above quote illustrates a highly technocratic perspective that seeks modular packages of information to be applicable across all sectors consistent with the military ethos. Faced with the implementation of the NDM Framework and the associated budget to spend, the NDMA priorities were operationally established. Identification of risks and vulnerabilities did not feature in that priority. About the Lai, the NDMA chief said that it was a backyard pet project and it would figure very low on NDMA's role at a national level because of its small scale. NDMA is also severely constrained by availability of qualified staff. Two advisors seconded from international organisations and some other non-technical support staff supported the General. Lack of subject specialists also explains the difficulties in programmatic priority setting within NDMA.

The NDMA chief was, however, quite receptive to our potential input in his programming, though somewhat skeptical of our intentions. As he specifically asked one of the authors as to why DfID had decided to bestow its 'favour' (*nazr-e-karam*) towards him. Prior to the meeting with the General many of his junior officials were quite vocal about the misbehavior of the NGOs and how they were dancing to the tune of their foreign masters. The tension of a terrain being pluralised is clear. One of the biggest concerns driven by the stereotypes about the NGOs on part of the government in Pakistan is that the NGOs make money hand over fist from international donors and that they are deeply corrupt. An academic or research organisation does not typically feature in Pakistani policy discourse and hence most government functionaries tend to equate them with NGOs and their institutional nightmares. The challenge for any policy intervention will be to negotiate that wall of hostility on part of the government, especially if the organisation is walking on the table without any funding.

The tension of a terrain being pluralised is clear. One of the biggest concerns driven by the stereotypes about the NGOs on part of the government in Pakistan is that the NGOs make money hand over fist from international donors and that they are deeply corrupt.

In terms of dealing with the reality of a military led federal institution, or for that matter even at the provincial level, it will be a challenge for any organisation to establish itself as a 'patriotic' organisation which is not making any money from their intervention.

We had discussions with ERRA, which has been mandated to coordinate the earthquake reconstruction activity. For risk reduction their primary input has been the design of seismic proof housing.

All those compensated for loss of shelter must follow a standard design given to them. Due to non-availability of cement in some far-flung high altitude areas, a second design that used local material such as wood etc. was allowed. Probed on whether this approach may be too restrictive the operative said that this was the only way to monitor compliance and all houses built with government's compensatory grants were checked at different stages of construction before the next *tranche* of the grant was released.

Although these were not formally part of DRR, the direction of ERRA indicated that improvement of banking and communicating were positive side effects of the relief activities.

The director ERRA identified drought as the second biggest hazard in the area. He said water availability was a serious issue and that he had read in the media that this year was going to be the hottest recorded year in history. As mitigation measure ERRA is encouraging water harvesting and has mandated the construction of toilets (in an area with over 70% open defecation) in all new houses. Water harvesting has become a requirement for new buildings and is enforced in the public sector. These buildings meet requirements of building codes before they are approved for construction.

In terms of enforcement the ERRA director said that as long as there is government subsidy, the two approved designs enforcement can be ensured. Afterwards, compliance especially in rural areas would be difficult to monitor. He thought that strengthening municipal capacity with qualified architects and engineers would be a cost effective risk reduction measure and some innovative mechanism for far-flung areas need also be devised.

He thought that people in far-flung areas and women were particularly vulnerable. In these areas, people were unable to access cash (government grants or from relatives) because they did not live close to a bank or had bank accounts. He said that families who had member outside AJK would send back remittance and collected funds from other sources. A lot of them, however, had to repatriate to support the bereaved families and help taking care of injured. This compulsion has pushed those families further into poverty as they had lost their source of livelihood outside AJK.

According to the director, one of the positive outcome of the earthquake calamity was that people were given identification cards and were introduced to formal banking. Also with the increase of cellular phone network people feel more secure because they are able to call for help in case of similar events in the future. Lack of communication was one of the main risks people faced in the aftermath of the earthquake and many were not attended to in the first few days.

For reconstruction activities, and plans for food and shelter supplies ERRA relies on weather forecast by the Meteorological Department. The agency's winter plan relied heavily on such weather forecasts. ERRA did not know if anyone in the government was concerned with climate change information, though they were aware of its risks through international media and internet as main source of information.

At the provincial level the research team met with Chairman, Planning and

Development Board of Punjab, which plans and approves all public sector development activities (SLD 06/12/2006). He said that the one of the weaknesses of the new local government system is that disaster management has slipped through the cracks. He had been the Assistant Commissioner in one of the earthquake-hit districts and had many more power to deal with calamities. They were able to commandeer vehicles and mobilise a quick response, whereas, the elected leadership neither had the authority or the sense to deal with such situations. According to him, the local leadership was busy dispensing patronage to their constituency with all the relief goods. He said that there was lack of research on public policy in Pakistan and he looked forward to our findings and their implications for the province.

At the local level we held meetings with the *tehsil nazim of* Rawalpindi, the equivalent of the City Mayor regarding his perceptions on flood and other hazards associated with the Lai. He stated 'development' as his key priority but said that because of the unique structure of local government in Rawalpindi District he did not think that the City Nazim had the requisite authority or the funding to undertake developmental activities in the cities. Similar sentiment had also been echoed earlier by the Deputy Fire Chief and are reported later. The *tehsil nazim* explained to us the Rawalpindi city (a *tehsil*) with a population of about 1.5 million is part of Rawalpindi District, which includes six other rural *tehsils*. The district Nazim with all the power and funding typically hails from rural *tehsils*. Therefore, the Rawalpindi City Tehsil has to compete with rural *tehsils* for funds from the district, even though the city probably generates about 90% of the tax revenues. Consequently the Rawalpindi City Nazim deemed himself to be handicapped by this institutional arrangement.

In terms of flood the Lai the *Nazim* thought risk from that the upcoming road project along the Lai held the best promise of reducing flood peaks in the river. The mechanics of how that might facilitate the reduction of flood peaks was something we politely refrained from asking and he did not elaborate on. In essence it seemed that the Nazim thought that 'development' was construction of more infrastructure was his main mandate and he was doing what he could with Rs. 30 million that he said he had in his coffers with considerable help from the federal government. He was a relative of an influential federal minister and one of the Pakistan National Assembly representatives from the city. Talking of disaster management he informed us that the city did not even posses a ladder that could reach above two-stories and was hence handicapped in an effective response. The interest in building expensive roads and not purchasing ladders indicates the political incentives do not rank risk reduction as a major prioirity.

In terms of flood the Lai the Nazim thought risk from that the upcoming road project along the Lai held the best promise of reducing flood peaks in the river.

The question of ambivalent institutional structures and engineering bias were also evident from other interviews at the local level. In our meetings with the Rawalpindi Fire Department, Rawalpindi Development Authority (RDA) and other members of the *tehsil* administration the emphasis were on engineering and technical solutions to the Lai flood problems, e.g., the deputy project director of the Japanese funded

Lai Telemetric System had the following suite of solutions to the Lai flood problem:

- The sides of Nala Lai should be paved. If you build sloped walls there, people will not be able to build any more houses.
- 40-50 meters wide roads should be built.
- Building the wall and roads could stop the population expansion.
- A barbed fence should be put around it.
- A proper scheme is required.
- Developing a Diversion Channel in Islamabad is the most important thing.

Institutional issues raised major questions regarding the sustainability of the early warning system on the Lai.

Similar technical orientation was confirmed during our meetings with the Federal Flood Commission (FFC), which was main federal agency responsible for flood mitigation in the Lai. The officer concerned there, reported to us that at the moment, diversion of two of the tributaries of the Lai into the adjoining Korang Basin is a priority project being considered by the FFC.

The deputy fire chief was particularly vocal about the ambivalent institutional structures. He gave us a briefing on the new telemetric system that had been put in place with Japanese assistance. He said that there was some controversy about who should run the system but it was decided finally that since the fire department was the first responder to emergencies and also happened to be the one to convey flood warning to the people it should be the one running the system. But then it could not be decided who should run the fire department. The Lai flooding is primarily the responsibility of the Rawalpindi city which comes under the Tehsil Municipal Administration (TMA), but the Fire Department is under the administrative control of the District Government which is oriented towards the much larger, mostly rural area which forms the vote bank for the district leadership. Consequently, although the Fire Department is under the district government its leadership is relatively indifferent to the issues of the city because they hail from the adjoining rural areas of the district and tend to focus their resources and energy towards the rural areas.

Being an old and visibly proud resident of Rawalpindi, the deputy fire chief did stress that the Rawalpindi could reap benefits from having Lai in its midst, just as it had in the past. He, however, stressed that the old institutional issues were continuing to hamper any attempts at service delivery by his organisation, e.g., he mentioned that even though the Fire Department had been made in-charge of operating the telemetric system, it had not been allocated any budget for its operations and maintenance. It was also pointed out to us that they had to hire guards for the telemetric stations and get vehicles to get to the monitoring stations for maintenance. But they did not have any vehicles, nor did they have a budget to hire additional personnel. So what was going to become of the system was unknown to our interviewees, though they did say that once operational the system could provide up to an hour of advanced warning of a flood, which could save many lives.

Civil Society

In the NGO sector the themes of governance, accountability and nesting of disaster management within broader political issues were very pronounced. It appeared that with the massive inflow of donor money into disaster response and management in the aftermath of the Asian Tsunami and the Kashmir earthquake, many organisations with no previous experience of disaster related programming had entered the field. By its own admission ActionAid Pakistan was one such organisation. Providing the context of Actionaid's programming in disaster management its director of disaster management unit, said that there was considerable dissatisfaction with the haphazard disaster response after the earthquake. She said 'we need to fix the fundamentals first, e.g., corruption in public life, before we can have effective disaster response systems . . . and you have to involve the people [in governance and programming] to prevent corruption.'

Sticking with the theme of addressing corruption and improving governance she said that instead of getting on the bandwagon of service delivery in the aftermath of disasters Actionaid has been focusing on forming citizen committees at the district level to keep the authorities accountable in the process of relief and reconstruction. Actionaid itself has been providing long-term capital and livelihood based support to communities, e.g., temporary shelters, livestock replenishment, woodcutting machines, watermills and development of community centers.

Despite frequent probing the Actionaid representative did not demonstrate any concrete understanding of what DRR may mean. She stressed that the fundamentals needed to be changed, political will for development had to be found, and basic standard of construction be developed, but was vague in terms of specifics. Although, she decried the service delivery orientation of many organisations but yet reported precisely such activities, as organisation's programming. She did however, say that the whole notion of public private partnership was part of the international donor agenda and it had little relevance to the Pakistani context. Furthermore, financial mechanisms like micro-credit or micro-insurance in her view were impractical in Pakistan.

The interview demonstrated considerable political awareness and attention to institutional barriers but little in terms of how broad principles were to be translated into practical policies. This finding is consistent with earlier such surveys by Mustafa (forthcoming). There is an entire rhetoric that has developed around the NGO sector in Pakistan and many of the NGO operatives have an admirable grasp of development but are short on the conceptual and practical implications, rather casually thrown around in conversations. This interview was unfortunately no different.

The views of representative from Plan International were slightly different and he opined that they had always worried about environmental risks and vulnerability of the poor upland populations although their primary concern was food insecurity as a result

There is an entire rhetoric that has developed around the NGO sector in Pakistan and many of the NGO operatives have an admirable grasp of development but are short on the conceptual and practical implications.

Insurance mechanisms for risk spreading are being tested in a variety of contexts.

of drought (SLD, 27 / 11 / 06). In the context of the risk reduction he thought that identifying threats, raising awareness on them, building designs, poverty reduction and alternative (diversified) earning strategies would be the best risk reduction measures. He saw risk reduction as a very cost effective in reducing damage. He viewed the government as coordinator and not a savior.

Aga Khan Foundation had started risk reduction activities within its development programmes. The agency perceived that risk reduction should be a ground up strategy. The foundation was training their partner communities in mountain rescue and seismic resistant terracing. They prioritised micro-zonation and information and communication technology as major risk reduction strategies. They were particularly interested in micro-insurance and informed that with the help of Gates foundation livestock and health micro-insurance was being piloted in three countries (SLD, 30 / 11 / 06).

Punjab Rural Support Programme (PRSP) has been a part of one of the first micro-insurance initiatives in Pakistan (SLD, 05 / 12 / 06). They claimed that such financial mechanisms against risks were always present but we have found new names for them. Grameen Bank had a practice of waiving loans to those affected by flood and provide them new loans to recover. Borrowers were viewed as partners. PRSP itself gives micro insurance in a credit-life programme where getting life insurance is mandatory within a loan. The insurance pays back any overdue amount of the deceases loanee and also the funeral cost at a nominal addition to the loan amount. They are now in the process of developing a cheaper insurance that covers in-patient expenses for the loanee. They reported that although they have not thought of insuring productive assets such as crops and animals, they had looked into insuring health and education. So far, however, the costs were too high for the poor communities. He said that if people are organised they can seize many opportunities and proactive risk reduction measures are cheaper and more effective.

The representative of the Urban Poverty Alleviation Programme from National Poverty Alleviation Programme said that NRSP and Adamjee Insurance had an ongoing micro-insurance programme that covered accidental death and hospitalisation (in-patient) expenses. He said that disaster management was not a part of the programme although many of the micro-credit clients were Lai flood affectees. He also opined that insuring assets would be a great strategy for disaster risk management but control on productive assets was a difficult issue (SLD, 12 / 12 / 06).

The Urban Poverty Reduction Project of the National Rural Support Programme had some experience with micro-insurance. They had a contract with Adamjee Insurance and insured accidental death and hospitalisation (in-patient healthcare) for Rs. 250 per annum (USD 42 eq.) In the second year they were preparing a product with half the cost that reduced Rs. 25,000 in-patient coverage to Rs. 15,000 to make it more attractive to the poor communities. The manager of the credit programme (SLD 12 / 12 / 06) said that disasters were not insured in Pakistan as yet. However, some of the urban

communities were hit by Lai flooding. After checking repayments for that month, no defaults were found and there were minimal deferrals! Even Rs. 5,000 overdue was paid off in the next month. He said that theoretically assets can be insured but controllability is an issue that must be overcome. He also informed that Adamjee Insurance was also insuring the cash in transit for the organisation.

The Micro-Finance Network is a project that supports micro-finance institutions in Pakistan. The membership fees do not cover its expense and DFID has provided financial support. The network has managed to support a study on demands for micro-insurance. Their most important contribution to the sector is generating a quarterly update about micro-finance activities in the country and conducting thematic studies. The network representative said almost all major insurance companies were interested in developing a micro-insurance business.

However, there were two insurance companies (non-members) that we met with later that provided micro-insurance for crops, farm animals and farm implements by insuring the loans given out for this purpose. The outreach of these loans cum insurance is small but spans across Pakistan. Currently the insurance companies are lobbying for a legislation that would make insurance a mandatory part of micro-credit and the companies sees this as the only way of keeping insurance affordable by spreading risk across the board. In case of the credit life schemes the Adamjee Insurance representative said cost was kept low with the caveat that in case of the government declared calamity (usually a major event) the loans were supposed to pay the balance of coverage amount that was not received from other sources. The government's compensation in most cases is larger than coverage of the credit life amount.

Multi-lateral Agencies

Interviews with the UN system operatives revealed that they developed the Early Recovery plans and the National Disaster Management Framework for the government of Pakistan. This was the official policy stance on both subjects. The UN system was at the forefront of organising the relief efforts among multiple foreign and some local actors and provided the bulk of material and technical support. The UN system is committed to DRR in Pakistan but has some difficulty in convincing the government towards this strategy. In their view there was a technical and relief bent in the military headed disaster management infrastructure in the country. The management cannot get over the importance of helicopters in emergency. However, the UN with help of bi-laterals has mobilised for funding disaster management infrastructure in the country. Besides the military executives, the technical staff of both ERRA and NDMA is hired and paid by the UN system. All inquiries on organisational stance on issues of hazards and risk reduction are referred to the Early Recovery and National Disaster Management Framework as the UN was an integral part of technical support in framing the document and, therefore, showed full confidence.

The UN system is committed to DRR in Pakistan but has some difficulty in convincing the government towards this strategy.

Summary of Insights from Institutional SLDs

The SLD process indicates the low level of awareness at all levels regarding the underlying factors that may contribute to risk reduction.

Muzaffarabad

Strategies for DRR that emerged through the SLDs at the community and at higher institutional levels that are being implemented focus on the following:

1. Structural measures, principally improvement of building design for earthquakes;
2. Training of masons to construct earthquake proof housing.
3. Training and capacity building within both government entities and local communities for disaster response (primarily rescue) with a limited amount of additional training of key target groups such as masons for structural risk reduction;
4. Community organisation to identify and plan potential local risk reduction measures in addition to their primary focus on relief and reconstruction (the DRR component is minor);
5. Discussions regarding spatial planning–the relocation of Balakot–with very little probability of this occurring in practice;

The SLD process indicates the low level of awareness at all levels regarding the underlying factors that may contribute to risk reduction in relation to earthquakes, other current hazards (drought, floods and landslides) and the less easily perceived consequences of climate change. Virtually all measures that are perceived as contributing to disaster risk reduction are focused on immediate risks and are of debatable sustainability. As illustrated by the excerpts from SLDs, interventions are not perceived as related to risk reduction unless they are explicitly and exclusively intended for that purpose.

Lai Basin

Technology leads the DRR debate in the higher policy and to some extent at the community level. There is a vested interest of the relevant department organisations in giving a solution that suits their mandate. The Frontier Work Organisation has proudly displayed billboards boasting the largest turnkey infrastructure project in Pakistan. Even at the community level people (mostly men and some women) think of a miracle cure that will tame the Lai for e.g. people feel that Lai can be deepened. After the ranking and costing exercise at the community level this idea seemed possible but not probable. Conversely, solid waste was identified as an omnipresent hazard some thinking on its clearing and the associated cost made it more desirable. Therefore, while the powerful organisations have very strong interest in physical solution, the affected communities are much more open to looking at structural and non structural measures.

Disaster risk reduction is a growing buzzword that is understood a little better within NGOs, especially among those working in disaster related relief activities. In the government's planning

documents it is seen equivalent to poverty. The appreciation for creation of hazards, vulnerability and the causality between risk and poverty is yet to be understood. Since this connection is conceptually missing, risk reduction is also absent in actual programming. The Japanese funding agency JICA has produced a comprehensive drought mitigation programme for the Lai, which is based mainly on large structural measures. The programme includes check dams in the catchment area, a lake upstream of the flood prone area and diversion of three of the main tributaries to another river. These measures could be effective except that they would be prohibitively expensive and have far reaching environmental and social impacts.

Most see DRR as important but something that is not tangible. They would wish that it were included in development but don't know how. In many of the SLDs one had to point out that some of the work that they did was indeed DRR. Very few are willing to actually invest in DRR at the planning and design stage of projects and hence it does not get included in the mainstream development activities. It is not an explicit part of most of Government's planning documents especially PRSP. Some of the newer donor policy documents include it but as something politically correct (among gender, environment etc.) rather than serious intervention.

Reactive thinking is found across all sectors and communities. NDMA wants helicopters, the TMA wants ladders and the Fire Department wants trucks. Amazingly the communities also prefer helicopters. To some extent the attribution of hazard to nature, chance and rarely God's will is an indication of the lack of understanding and underplaying of the role of the social and political factors that combine with natural phenomenon to create hazards. The government authorities have little idea of the larger picture and look at disaster from event to event, and sector to sector. The federal level actors (at the moment mostly military) when asked about risk reduction, focused on response. The idea of comprehensive planning and inclusion of risk reduction in mainstream development activities seemed like a novel idea to them or something that was far-fetched and somehow lower priority probably because of lack or urgency in the idea.

Most organisation see DRR as important but something that is not tangible.

The communities are, however willing to consider a much wider range of choices for risk reduction in the Lai area, although they also wish for a cost free (entirely government funded) silver-bullet technological solution. This receptivity at this level would add to the sustainability of risk reduction measures if they were undertaken with consultation of the affected.

There hasn't been any serious thought given to the institutional side or looking at the Lai as in issues of multi-jurisdictional organisational confusion that happen to be responsible for different parts of the small Lai flood plain which may allow a more holistic approach to the DRR. The NGOs are confused about the whole situation but stress heavily on the softer side especially the old mantra of community training and mobilisation and stay away from technology. They, however, have a very prominent role to play not only in response and recovery but also in risk reduction, awareness raising and advocacy to various players. The

shortcoming here is the lack of multi-sectoral technical knowledge on these issues.

Among the actors in the Lai basin there is the pure competitive spirit among actors in . The donors tend to lead the agenda. The planning commission, as the apex development policymaking agency, is not involved in much of the disaster risk reduction debate and there is the struggle between the better-funded military led initiative and the previous bureaucratic powerhouses to obtain funding for development activities (e.g Lai Expressway).

NGOs are vocal about communities concerns but have little effect on mainstream development activities and have not invested much in the Lai Basin themselves. The need to work across sectors to capture the root-causes of hazardscape creation is therefore difficult, if not impossible to address in the current competitive and at times antagonistic institutional environment. Government's leadership and ownership is essential for implementing cost effective solutions for risk reduction.

Conclusions

By comparing the two cases one can see that there is evidence of scattered initiatives for direct investment in DRR. In Muzaffarabad building design and training of masons, for example, are targeted interventions. Although the intervention is essential, it is hard to predict whether these new technologies would have long-term adoption and if people in the next generation would still follow the practice once the earthquake is no longer a part of their personal experience. Similarly, in Lai Basin, the expressway along the banks of the river is a devised multi-purpose solution that on one hand would prevent overflow and facilitate garbage collection (and prevent dumping), and on the other help reduce traffic flow problems in the conurbation. Other proposed solutions are very costly and may even exacerbate the situation by creating a false sense of security or create risk in other areas (such as rarely used diversion channel occupied by poor squatters).

There are unintended systemic changes in Kashmir that have a profound long-term effect on building resilience in the communities. Cellular mobile communication, expansion of financial services, road networks and civil society intervention will not only facilitate recovery but is likely to diversify livelihoods, build social capital and expand opportunities for basic services like health and education. Therefore, areas that are not considered to be part of ambit of focused DRR interventions may in fact lead to a more sustained DRR especially if the basis for these systemic changes is lead by a business model rather than policy alone. In Lai, development policy, which is an outcome of competing organisational interests, can possibly lead to increased vulnerability, and relegates DRR to a secondary objective among varied organisational and developmental objectives.

Bibliography

Blaikie, P., T. Cannon, I. Davis and B. Wisner (1994). *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. New York: Routledge.

CRPRID (2006). *Pakistan 2005 Earthquake: An Assessment of Impoverishment Risks*. Islamabad: CRPRID.

Cutter, S. (1996). Vulnerability to environmental hazards, *Progress in Human Geography* 20(4): 529-539.

Dove, M. R. and D. M. Kammen (2001). Vernacular models of development: An analysis of Indonesia under the 'New Order', *World Development* 29(4): 619-639.

Hewitt, K. (ed.) (1983). *Interpretations of Calamity*, Winchester, MA: Allen and Unwin Inc.

Hewitt, K. (1997). *Regions of risk: A geographical introduction to disasters*. Harlow, U.K.: Longman.

Japan International Cooperation Agency (JICA) (2003). Comprehensive Flood Mitigation and Environmental Improvement Plan of (sic) Lai Nullah Basin, Islamic Republic of Pakistan. Islamabad Pakistan: JICA and Federal Flood Commission (FFC).

Kates, R. and Ian Burton (1986a). *Geography Resources and Environment: Selected Works of Gilbert F. White*, vol. 1. Chicago, IL: University of Chicago Press.

Kates, R. and Ian Burton (1986b). *Geography Resources and Environment: Themes from the work of Gilbert F. White*, vol. 2. Chicago, IL: University of Chicago Press.

Khan, Sher Baz (2004). Nullah Leh project's affected people: Compensation not given as planned. The Daily *Dawn Islamabad*. 14 August: 17.

Mahmood, A. (2007). *Earthquake Vulnerability Assessment–Pakistan: 2005-06*. Islamabad, Pakistan: The Population Council.

Mitchell, J. K. (1998). Introduction: Hazards in changing cities, *Applied Geography* 18(1): 1-6.

Mustafa, D. and J. L. Wescoat Jr. (1997). Development of Flood Hazard Policy in the Indus River Basin of Pakistan, 1947-1995, *Water International* 22(4): 238-244.

Mustafa, D. (1998). Structural Causes of Vulnerability to Flood Hazard in Pakistan, *Economic Geography* 74(3): 289-305.

Mustafa, D. (2002). To each according to his power? Access to irrigation water and vulnerability to flood hazard in Pakistan, *Environment and Planning D: Society and Space* 20(6): 737-752.

National Engineering Corporation (NEC) (2002). *Study for Social Environment: Comprehensive Flood Mitigation and Environmental Improvement Plan of Lai Nullah Basin in the Islamic Republic of Pakistan*. Submitted to Japan International Cooperation Agency (JICA).

Pelling, M. (2003). Toward a political ecology of urban environmental risk: The case of Guyana.' *Political Ecology: An Integrative Approach to Geography and Environment-Development Studies*, eds. Karl S. Zimmerer and Thomas J. Bassett 73-93. New York: Guilford Press.

Rawalpindi Development Authority (RDA) (2003). Urban water supply and sanitation project Rawalpindi: Lai Nullah improvement works. Presentation by the Project Management Unit to the LEAD Pakistan Workshop on Lai Nullah Flood Hazard Management, Islamabad, Pakistan, 24 July, 2003.

Raza, S. I. (2004). Construction work on new GHQ complex begins. The Daily *Dawn*, September 6th, 2004. Retrieved on September 7th, 2004 from http://www.dawn.com/2004/09/07/nat14.htm

Spaulding, F. (1996). Architecture and Islamabad. Paper presented at the American Institute of Pakistan Studies Workshop on the state of Pakistan studies, Washington DC, Sept. 18-22, 1996.

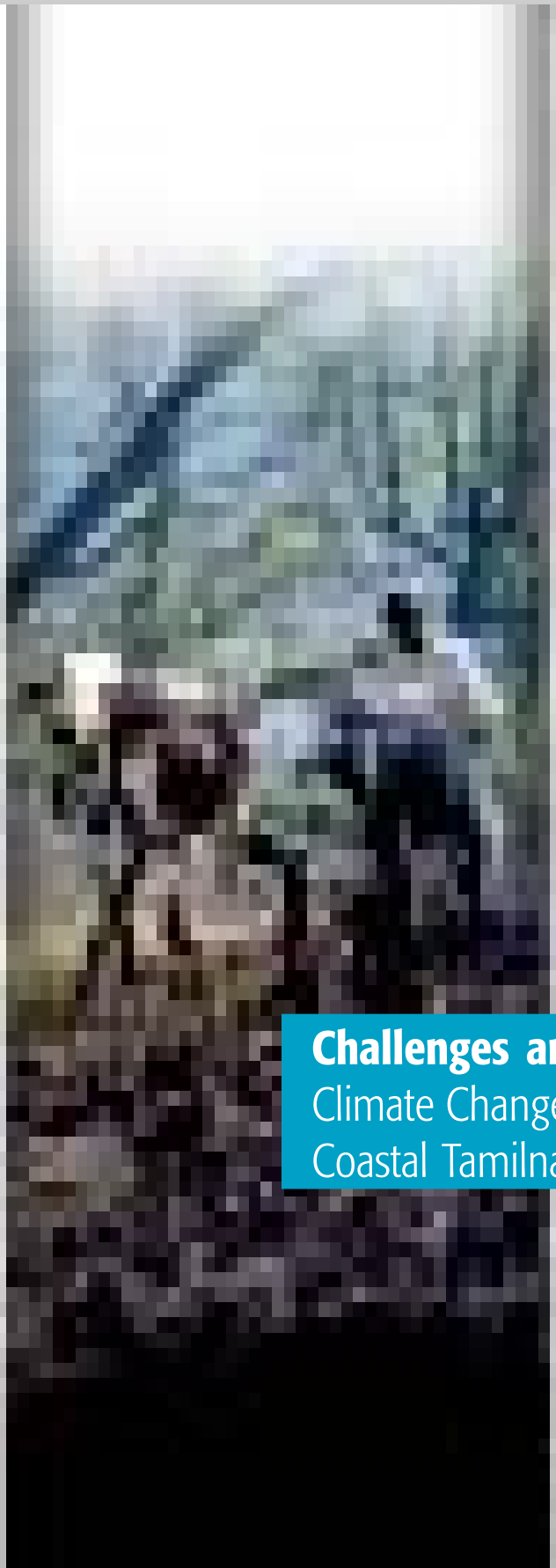
Watts, M. (1983). On the poverty of theory: natural hazards research in context. In *Interpretations of Calamity,* ed. K. Hewitt, 231-262. London: Routledge.

Wescoat, James L. Jr. (1987). The Practical Range of Choice' in Water Resources Geography, *Progress in Human Geography* 11(2): 41-59.

Wescoat, J. (1992). Common themes in the work of Gilbert White and John Dewey: A pragmatic appraisal, *Annals of the Association of American Geographers* 82:587-607.

White, G. F. (1945). *Human Adjustment to Floods.* Research Paper 29. Chicago IL: University of Chicago, Department of Geography.

Whyte, A. (1986). From hazards perception to human ecology. In *Themes from the work of Gilbert F. White, Vol II,* eds. R. Kates and I. Burton, 240-271. Chicago: University of Chicago Press.



CHAPTER 9

Challenges and Prospects for Adaptation: Climate Change and Disaster Risk Reduction in Coastal Tamilnadu

S. Janakarajan

Case Study Guidance Note

Country: India
Location: Tamilnadu
Date: May 2007
Sector and Spatial focus: Coastal fishing and coastal agriculture
Title: Challenges and Prospects for Adaptation: Climate Change and Disaster Risk Reduction in Coastal Tamilnadu
Bibliographical reference: S. Janakarajan (2007) Challenges and Prospects for Adaptation: Climate Change and Disaster Risk Reduction in Coastal Tamilnadu

Abstract

This case study examines the challenges of climate change impacts and disaster risk reduction strategies in Tamilnadu. It outlines the existing prevalent responses by the people and by the government. Adaptation processes and strategies currently undertaken needed to better cope with future climate change impacts are discussed. These include the context of the potential rise in sea-level, accelerating sea erosion, increasing risks from cyclones and storms, the ongoing flooding and inundation due to backwater and freshwater floods, droughts, increasing salinisation of land and groundwater, etc. The Tamilnadu study is being undertaken in three ecosystems where the basic livelihoods are fishing and agriculture.

Technical Description

- **Hazard/risk type:** High wind speeds with heavy rainfall, flooding, sea water ingress, inundation, salinity of land and groundwater, excessive heat
- **Type of assessment:** Vulnerability and risk assessment, initial cost-benefit analysis and strategies for possible interventions, long-term adaptive strategies.

Contextual Notes

- Tamilnadu's 1,061 km of coast is the second longest coastline in India. The livelihoods of millions of people are supported along this coastline, based on marine fishing and fishing in numerous backwaters. 700,000 people depend on marine fishing for their livelihoods, spread over 591 coastal villages. Many hundreds of fishermen and farmers are already facing severe threats due to the pollution load dumped in the backwater rivers by industries, cyclonic storms, floods in the Cauvery River, sea water flooding agricultural land, etc. They are constrained due to lack of skills to diversify from their traditional livelihoods. The potential impacts of climate change are quite likely to aggravate the problems already confronted by the people.

Research and Analytical Process

- Methods / tools used: Initial secondary data collection from various governmental and non-governmental sources, literature collection, time-series data collected from the Indian Meteorological Department, a series of shared learning dialogues at village, mid- and state levels, ranking potential costs and benefits of strategies to reduce risks as perceived by communities, etc.

Key Insights Generated for Vulnerability Reduction and Capacity Enhancement

A. For fishermen in all ecosystems:

- Except in some places there is no bio-shield in the villages. Mangroves could benefit and save the fisher population. Many people have shown a preference for coconut trees as bio-shielding.
- People need to aquire non-fishing skills such as carpentry, masonry, electrical works, plumbing operations, heavy vehicle driving and communication.
- Access to insurance and credit.
- Training in fish processing such as manufacturing of fish pickles, prawn pickles and tinned fish, and training in exporting these goods.
- Need better schools and particularly education in the English language.
- Everyone appreciated the idea of a community FM station for information dissemination during times of disaster.
- Safe drinking water is one of the most important demands. The groundwater is saline and polluted.
- A Village Information Center (VIC) is considered a good facility but needs to be integrated with people's preferred needs. There is a case for strengthening existing VICs by providing them with reliable climate information.
- Sponsoring young boys and girls for industrial training, computer training, science courses, training in NGO activities and the English language.

B. For agriculture dependent populations in all ecosystems:

- Skill acquisition in non-farm activities such as industrial trades (fitter, welder), carpentry, masonry, plumbing, electricals and electronics servicing.
- Sheep breeding and dairy, fodder which could be grown within the village even on saline land (*subapul*, for example, is a salt resistant fodder crop). Several other crops could be grown in brackish water and used as animal fodder. Sheep breeders are less affected by these problems.
- Poultry farming as another alternative livelihood.
- Training in brackish water shrimp and fish farming.
- Sponsoring young boys and girls in employment oriented courses such as industrial training, computer training, science courses, training in NGO activities, English language courses, etc.
- VIC and FM radio services.
- Improving the local library with Tamil and English newspapers for information on education and employment opportunities.

Strategic Notes and Lessons Learned - Key Points to Emphasise

- Compared to the vulnerable groups, those who are unaffected by disasters face lesser impacts due to key behavioural or other differences. These differences, once identified, can be used as points of leverage for removing the same factors that make other groups vulnerable.
- Shared learning dialogues were found to be an extremely useful method to analyse and document risks and vulnerabilities of different groups. These methods also allow the identification of non-land based and non-fishing based livelihood strategies for reducing vulnerability and enabling adaptation.

Keywords: Coastal livelihood, Tamilnadu, climate change, disaster risk reduction.
Resource person(s): Dr. S Janakarajan (janak@mids.ac.in), Madras Institute for Development Studies.

Introduction

Coastal cities and towns of Tamilnadu are vulnerable to the impacts of climate change.

People living in Low Elevation Coastal Zones, areas within 10 meters above sea-level, are, according to a study carried out by Gordon McGranahan from the International Institute for Environment and Development, highly vulnerable to the impacts of climate change, particularly sea-level rise.[1] In India, over 63 million people live in this low elevation zone. Gujarat and Tamilnadu, where the coasts are over 1,000 km long, will be the most affected states. Orissa and Goa are also highly vulnerable to sea-level rise.

Within Tamilnadu, the worst affected region will be the Cauvery delta, which encompasses the whole of Nagappattinam District and parts of Cuddalore District. The Cauvery delta's 1,800 year-old irrigation system is a complex network of rivers, canals and drainage systems with thousands of miles of canals and channels. Nagappattinam District, which almost entirely lies within the delta, is a narrow stretch of land 165 km long and 15-20 km wide. This district has two major disadvantages: a) most of the district falls within the low elevation coastal zone, and b) 56% of the land also lies below sea-level. A further 18% of the district which is just at sea-level is water-logged and marshy. Already the Cauvery delta, on the whole, suffers from saltwater intrusion up to five kilometres inland, as well as severe drainage problems. Due to its flat terrain, the region is prone to flooding from drainage canals and sea water, particularly during the October to December monsoon months when most of the monsoon rain falls within a few days and is often combined with cyclones and high wind storms.

In the Nagappattinam District, 90% of the population consists of small and marginal farmers with a very high concentration of landless agricultural labourers. Furthermore, the coastal region of Tamilnadu is very densely populated (528 people / km^2, almost double the state average of 372 people / km^2). Pollution and land degradation from rapid industrialisation along the coastal region, and in particular in the cities of Chennai and Cuddalore, has further aggravated the situation and made coastal cities and towns more vulnerable to the impacts of climate change. Many chemical, textile, oil refinery, thermal power and fertiliser industries are established along coastal zones for easy disposal of effluents into the sea. The predicted impacts of climate change such as sea-level rise, increasing intensity and frequency of cyclones and storms, coupled with existing anthropogenic factors, will aggravate this already vulnerable situation. Long-term, non-land based adaptive strategies are needed for the region rather than simple engineering solutions.[2]

All adaptive measures undertaken to date have been ad hoc and structural,

[1] The Hindu, March 29, 2007

[2] NCRC (2007), Mapping and Study of Coastal Water Bodies in Nagappattinam District.

with largely no effect. Non-land based, long-term disaster preparedness, risk reduction strategies and early warning systems have not been part of any policy planning framework so far. The present case study aims to look at adaptation from a much broader perspective.

Objective

This case study examines the challenges of climate change impacts and disaster risk reduction (DRR) strategies in selected districts of coastal Tamilnadu. It also outlines the responses made by the people of Tamilnadu governments. The processes of adaptation currently undertaken and strategies needed to better adapt to future climate change impacts are discussed in the context of potential rise in sea-level, accelerating sea erosion, increasing risks from cyclones and storms, the ongoing flooding and inundation due to backwater and freshwater floods, droughts, and increasing salinisation of land.[3]

Concepts and Key Issues

Certain behavioural or other attributes allow some people to remain relatively unaffected by the impacts of climate change. We need to work with communities to identify these differences in behaviour or other attributes. By doing so, we can identify points of leverage (policy, infrastructure, etc.) for removing the constraints that limit affected groups from undertaking the same changes in order to reduce their vulnerability to the same impacts. Then we can identify strategies that will be able to respond to local conditions and the incentives of the local groups. This idea is being developed as follows:

- Mainstream disaster risk reduction strategies as part of the regular planning and policy processes. This task involves a comprehensive assessment of risk and vulnerability, identification of existing coping strategies, and developing ways to strengthen the capacities of vulnerable communities to respond to these changes.
- Establish links between concepts (such as disaster risk reduction and adaptation to impacts of climate change), shared learning dialogues as a two-way learning process to understand the impacts of climate change and community-based risk reduction, and other strategies.
- Incorporate climate change information into community-based risk reduction strategies facilitated through shared learning dialogues.
- In order to develop effective mechanisms for adaptation, identify groups less vulnerable than others to the impacts of climate change and those factors that constrain or enable different groups to respond to disaster events.

An increase in sea-level implies a major risk to those whose livelihoods depend on coastal ecosystems. These communities will clearly need support to offset climate change impacts. At a

Non-land based, long-term disaster preparedness, risk reduction strategies and early warning systems need to be promoted.

[3] A backwater river is that part of a river, within a delta, that is brackish and represents the interface between freshwater flowing from inland and sea water moving inland as a result of tides, sea-level rise, and a decrease in freshwater flow.

minimum, the state must play a facilitating role to enable coastal communities to transition and adapt to changes to their ecosystems. The knowledge and awareness local communities have about climate variability and change including its impacts and how they will be affected needs to be identified.

Communities need support to offset climate change impacts.

This chapter first discusses the demographic characteristics, including livelihood occupations, of each case site. It then outlines a description of the existing hazards of each area and how climate change might impact these areas. The next section discusses the process of shared learning dialogues and vulnerability analyses and describes the key insights obtained. Then a discussion on the benefits and disadvantages of strategies identified for pilot implementation plans in each site follows. The final section discusses the project methodology and concepts summarising the key insights from the current research in Tamilnadu.

Tamilnadu: Coastal Area, Ecosystems and Vulnerability

The coastal ecology of Tamilnadu is highly degraded.

Among the coastal states of India, Tamilnadu's 1,061 km of coast is the second longest. Of the state's approximately 62 million people, about 29 million live along the thirteen coastal districts[4] whose livelihood is dependent on marine fishing and fishing in numerous backwaters. In 2003-04, 381,000 tons of fish were caught in the state, about one quarter of which was caught by small fishermen using non-mechanised boats. All along the coast, agriculture is another important livelihood. Tamilnadu's coastal wetlands have high hydrological, biological and socio-economical values.

The state's coastal area is exposed to multiple hazards: coastal floods, tsunamis, storm surges, cyclones and strong winds (Map 1). Along with the states of Orissa and Andhra Pradesh, Tamilnadu is most affected by cyclones. According to Kavikumar and Tholkappian (2006), India's eastern coastal districts (including those in Tamilnadu) are more vulnerable to coastal disasters than districts on the west coast. According to the Asian Disaster Preparedness Centre, four times more cyclones are formed in the Bay of Bengal than in the Arabian Sea. In addition to these hazards, coastal Tamilnadu faced a devastating tsunami in December 2004. The giant sea waves affected about one million people living in 376 coastal hamlets, killing an estimated 10,000 people. Most of the damage occurred in Cuddalore and Nagappattinam districts. The United Nations-Asian Development Bank-World Bank Joint Assessment Mission estimated the total direct damage at US$ 437.8 million, with an additional estimated US$ 377 million in loss of livelihoods.[5]

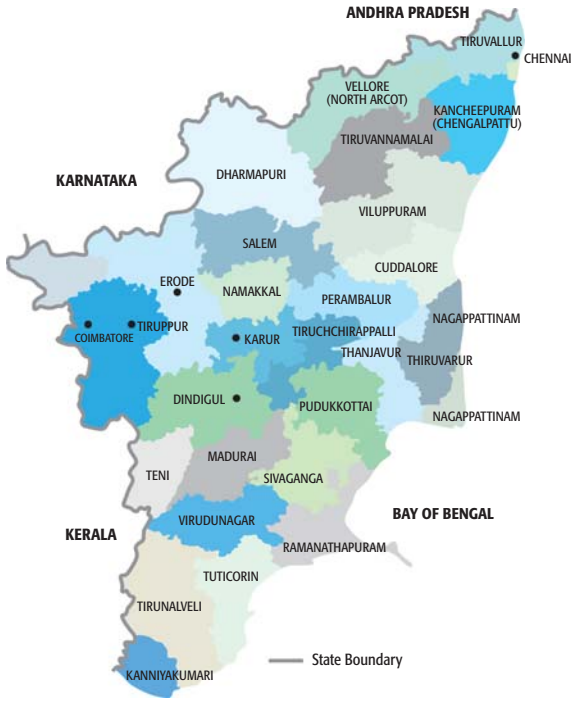
The coastal ecology of Tamilnadu, as with similar ecosystems elsewhere in India, is polluted with industrial wastes, groundwater is over-extracted, sea water ingress and sea erosion are in advanced stages, marine resources are over-exploited, coral reefs and mangroves are degraded. The threat of sea-level rise and other coastal hazards substantially aggravate the vulnerability of the coastal population. Studies indicate that there is a long-term trend in sea-level rise of about one millimetre a year, projected to rise to 2.5 mm a year. This compares to the global trend in sea-level rise of 46-59 cm[6] over the period of 2000-2090. This would amount to a 20+ cm sea-level rise along India's coastline for the same period. This is likely to represent a minimum since emerging scientific information suggests rates of sea-level rise may accelerate. Even given this low rate of rise, according to Aggarwal and Lal 0.41% of India's total coastal area and 4.6% of the coastal population (7.1 million people) could be

[4] Census data (2001)

[5] Krithika Ramalingam, India Resource Center, May 20, 2005.

[6] Diksha Aggarwal and Murari Lal: Vulnerability of Indian coastline to sea-level rise, http://www.survas.mdx.ac.uk/pdfs/3dikshas.pdf, accessed May, 2007.

MAP 1 | Tamilnadu river basins and districts



Source: S Janakrajan (1999)[10]

directly affected (TERI, 1996). The most vulnerable areas along the Indian coastline are the Kutch region of Gujarat, Mumbai and South Kerala, deltas of rivers Ganga (West Bengal), Cauvery (Tamilnadu), Krishna and Godawari (Andhra Pradesh) and Mahanadi (Orissa). The islands of Lakshadweep Archipelago would be totally lost. In terms of population, West Bengal, Maharashtra and Tamilnadu would be worst affected because of their high population density. The paper indicates that 0.07 million hectares of Tamilnadu's total coastal area of 13 million hectares are likely to be inundated by sea-level rise. The inundation will affect over 1.62 million people.

The Tamilnadu coast also sometimes experiences severe cyclonic storms in the October-December monsoon (Appendix 1). A study by Antonio Mascarenhas indicates that more than 1,000 cyclonic events have occurred in the Bay of Bengal in the last century.[7] Of the documented cyclonic storms, 55 crossed the coast of Tamilnadu, 69 hit Andhra Pradesh, 58 affected Orissa and 33 struck West Bengal . Mascarenhas quotes a study by Mani (2000) about historical cyclone events in Tamilnadu which shows that one event produced wind speeds exceeding 250 km / h and caused a 12m storm surge. Table 1 summarises the information available in Mani's study.

[7] Dona, P., Need for Setback Lines in Coastal Zone Management: A Meteorological Point of View, National Institute of Oceanography, Goa, India.

TABLE 1 | Wind Speed, Storm Surges and Inland Penetration of Saline Water Associated with Cyclones Along the Coast of Tamilnadu.

Period	Area affected	Wind speed (km/h)	Storm surge height (m)	Inland penetration (km)
November 1952	South Nagappattinam	Not recorded	3	8.0
December 1955	Thanjavur	200	3 to 5	3.0 to 8.0
October 1963	Cuddalore	139	6	Not recorded
December 1964	Rameswaram	193	3 to 5	Not recorded
December 1967	Nagappattinam	130	Not recorded	Thanjavur area
November 1978	Ramanathapuram	212	3 to 5	Not recorded
November 1991	Near Karaikal	89	Not recorded	0.25
December 1993	Near Karaikal	133	3 to 4	2.0

Source: Mani (2000)

The many types of hazards in coastal Tamilnadu debilitate the existing livelihoods of the region. Other challenges include changes in the coastal ecosystem, land use patterns that are socio-economically and environmentally degrading and sea-level rise and saltwater intrusion into coastal aquifers.

Study Sites

For the purposes of this study, three distinct ecosystems defined by access to livelihoods and availability of coastal wetlands were identified. In ecosystem I, the only livelihood is fishing; fishing and agriculture are the main livelihoods in ecosystem II, whereas ecosystem III is dominated by dry-land agriculture and backwater fishing. The particular issues facing each ecosystem and the potential impacts of climate change on each of the sites is discussed in detail further below.

Ecosystem I: Cuddalore Old Town[8]

Cuddalore Old Town (OT) (Map 2) has a population of about 30,000 whose main source of livelihood is marine fishing, supported somewhat by fishing in the Uppanar River. A small percentage of the population is small vendors, construction workers, road builders and industrial workers. Fisher folk belong to the community called *Parvatharaja kulam*, which is classified by the government as the most backward caste. Children as young as 14 stop going to school and are involved in fishing activities. Only about 10% of the population has attempted to diversify into other sources of livelihood.

Many types of hazards in coastal Tamilnadu debilitate the existing livelihoods of the region.

Shared learning dialogues were conducted in the Sonankuppam area of Cuddalore OT. These dialogues showed that there are only three castes of people in the area. Of the 547 households in Sonankuppam, 545 belong to the *Parvatharaja kulam* caste, with only one each from the scheduled caste and the caste of washermen. Of the 545 *Parvatharaja kulam* caste households, 91% are fishermen and 7% sell fish. The remaining 2% are government workers, seamen, weavers, small vendors, NGO workers and

[8] The response we received from the residents of Cuddalore Old Town was very weak and discouraging. People demanded money for every interview. This new behaviour, known as 'tsunami money', is a result of the flow of donations that came after the devastating 2004 tsunami. Nevertheless, the researchers still managed to obtain instructive information.

MAP 2 | Cuddalore old town

drivers. Table 2 below shows the educational level of the population of Sonankuppam.

Box 1 explains the kinds of problems confronted by children, especially school dropouts.

The Uppanar is a 30 km-long, backwater river along which 21 fishing hamlets are situated. This ecosystem is not only threatened by sea-level rise, coastal storms and cyclones, but also by increasing pollution. The growth of Cuddalore Old Town has made it one of the most polluted areas. Around thirty industries producing pesticides, pharmaceuticals, dyes and paints discharge their wastes into this ecosystem and their effluents have also polluted the groundwater on which the villagers depend. Ever since they began operating, in 1980, the local people have been complaining about air, water and land pollution.

The industrial effluent is discharged directly into the Uppanar River, affecting the livelihoods of small fishermen spread over 30 villages along the river's 28 km stretch. The residents feel that industrial pollution is a slowly unfolding disaster, with the fish catch having gone down by 80% since the industries opened. Some species of fish, such as *sudhumbu*, *navarai*, *sura*, *yeral*, and *kanavai*, have completely disappeared. Until two decades ago, shrimp catch in the backwaters was meant for export. Today, there are no shrimp. Whatever fish is caught cannot be sold because the fish smells of the chemicals. Instead, the fish is dried and sold to poultry feed manufacturers. Over 100,000 people who depended on river fishing, small-scale salt production and small-scale farming have lost their livelihoods due to the release of untreated industrial effluents. Those who have lost their fishing livelihood have become casual labourers. Since the labour market is not guaranteed, they face uncertain futures.

TABLE 2 | Educational Status in Sonankuppam

Sex	Population	Illiterate (%)	Students who completed primary School (%)	Secondary school dropouts (%)	Final year dropouts	Number going to college
Male	1240	40	26	23	10	1
Female	1222	41	30	20	8	1

BOX 1 **Problems faced by school dropouts in Sonankuppam**

We interviewed Madhavan, a 17 year-old boy who had to drop out of school in the 8th grade. His story is similar to hundreds of other young men of Cuddalore:

As a young boy, he was often late for school because he had to do his share of the household chores. His punishment for being late was to be beaten, which he feared. Then, three years ago, when he was in the 8th grade, his father suffered a fishing accident and became physically handicapped. Madhavan was forced to work to earn the family income, and became a coolie fisherman. But Madhavan does not like fishing. He gets up at 3 a.m. every morning and spends anywhere from seven hours to one week out at sea. The owner of the boat he operates does not allow him to return from sea empty-handed. When the sea is rough, Madhavan prays for his life, vouching never to go out again; but he has no alternative. Handling the fishing net is not easy, and yet, "I will be scolded and abused if I do a bad job" he told us. Fishing is difficult and very tiring, and yet, as soon as he returns from sea he cannot rest but must immediately lay out the net to dry, or else the next fishing trip will be delayed. On the day of our interview with him, Madhavan had gone out to sea at 3 a.m. and returned at 10 a.m. with two edachi fish weighing four kilos each. The Rs. 400 obtained from their sale was divided into three shares – one for the boat owner, one for the net owner, and the last equally divided among five labourers. Madhavan's own share was Rs. 40, which he gave to his parents. Madhavan is determined to see his 13 year-old sister, currently in grade 9, complete school.

These same chemical industries also release volatile organic compounds which have polluted the air to the point of causing chronic respiratory problems such as throat infections, constant headaches, tuberculosis, dermatological problems, gastroenteritis, early tooth decay (even in children), miscarriages and high incidences of irregular menstruation. We even came across eight young cancer patients. Many complained that even cooked food and the water they drink smells and that children sometimes vomit after eating. We observed in every village of Cuddalore OT that relatively new buckets (less than six months old) used to store groundwater were red from chemical residue. Until 1990, good quality groundwater was available below 10 feet. Today, the water table has dropped and the quality of the water is too poor to drink. Proposals for a new textile park, a PVC plant (Chemplast) and a petroleum refinery (Nagarjuna) threaten further environmental degradation.

Ecosystems II and III: combined characteristics

Ecosystems II and III are the most common on the Tamilnadu coast. Both fishing and agricultural populations exist here. As a result, unlike in the first ecosystem, villages are made up of multiple castes. Furthermore, these villages are larger and their populations distributed across many hamlets (Table 3). The population densities of 910 / km^2 in Vanagiri and 726 / km^2 in Pushpavanam villages are higher compared to the state and national averages of 528 / km^2 and 272 / km^2 respectively. The characteristics and livelihoods of the selected villages of ecosystems II and III are described in detail below. Each hamlet in each village is separated by caste and by livelihood, with fisher folk living on the coast and farmers inland. There has long been animosity between fishing and farming communities, such that the two do not mix. The main risks confronted by different social groups of Vanagiri, Pitchavaram and TS Petai villages are the same mentioned earlier for Ecosystem I.

TABLE 3 | Population, Number of Households and Hamlets, and Size of the Selected Villages in Ecosystems II and III

Ecosystem and village	Population			Number of households	Number of Hamlets	Total area (km²)	Population Density (per km²)
	Male	Female	Total				
Ecosystem II Vanagiri	3,670	3,622	7,292	1,623	9	8.01	910
Ecosystem II TS Pettai	554	569	1,124	281	2	3.17	354
Ecosystem II Pitchavaram	2,550	2,500	5,050	614	6	6.64	384
Ecosystem III Pushpavanam	3,150	3,100	6,250	1,779	11	8.60	726

The suitability of certain crops comes into question in a changing climate context.

The Kollidam, the main flood barrier of the Cauvery River is breached at least once every five years causing total loss of crops in TS Pettai and Pitchavaram villages. These villages are located at the tail end of the Cauvery delta where water drains into the sea. There are a good number of backwater rivers whose floods inundate agricultural land during dry months (March–September) when the Cauvery drainage canals are dry. Furthermore, sea water floods these agricultural lands, greatly increasing land and groundwater salinity. 50 years ago, the arrangement in the Cauvery delta was to let tail end regions receive irrigation water first. This practice has enabled farmers to start cultivation in June. But, with less water available in the Cauvery River, farmers upstream violate the practice and irrigate their fields. As a result, arrival of water to the farmers in the delta is often delayed until September, which coincides with the northeast monsoon. The canals act as flood conveyers and damage the crops. The original seasons of *kuruvai* and *samba* have disappeared; paddy and groundnut (winter crops) are cultivated in the *navarai* season starting in December and ending in April-May. Even one heavy spell of rainfall inundates land and it can take months for the floodwaters to recede. This occurs more often in Pitchavaram and TS Pettai. The main crop, paddy, is now only cultivated once a year. Groundnut once yielded 25 to 30 bags of pods (one bag weighs 40 kgs) per acre but now only yields 10 to 15 bags per acre. Groundnut is sensitive to climate conditions: both excessive heat and too much water lower the groundnut yield. The suitability of this crop comes into question in a changing climate context.

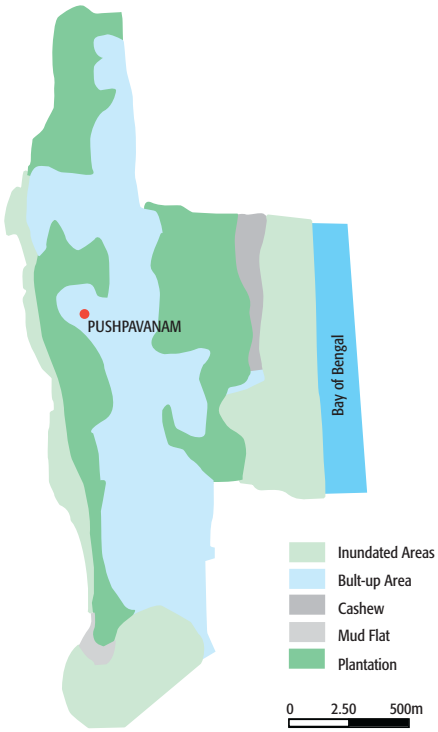
Ecosystem II: Fishing and agriculture are the two major livelihood activities for the villages of TS Pettai and Pitchavaram in Chidambaram taluk, Cuddalore District and Vanagiri village in Sirkazhi taluk, Nagappattinam District. Most of this ecosystem lies within the deltaic region of the Cauvery River. Besides coastal flooding, high flows in the Cauvery River and its numerous backwater tributaries cause inundation, the natural flooding cycle of the Cauvery River having been altered by upstream interventions. The use and allocation of the Cauvery water is an issue of heated dispute between the states of Tamilnadu and Karnataka. Since the late 1970s, the river acquired a seasonal character (it was perennial before), remaining dry for over six months of the year. This change in the river's hydrology has increased the occurrence of flooding from the sea and has aggravated salinisation of the land and groundwater, making drinking water

scarce. This salinisation and reduction in freshwater flow is also threatening the 3,500-acre Pitchavaram mangrove forest.

Ecosystem III: In this ecosystem, the main livelihood is agriculture, while marine fishing supports a small section of the local population. Pushpavanam (Map 3) is surrounded by backwater rivers on three sides. Although the village lies within the delta, gravity flow irrigation from the Cauvery River is impossible because it is at a higher elevation. In the immediate post-monsoon period, the groundwater level is about 10 feet underground. In the summer months, the level drops and the water salinity increases. As a result, drinking water is dangerously scarce and irrigation very difficult. Crops are mostly rain-fed and paddy crops are planted by directly sowing the seeds rather than transplanting seedlings. Sea water flooding is a constant threat.

Nagappatinam District: On the whole, the district of Nagappattinam (most of it lies either below sea-level or between 0-5 m above sea-level) and one taluk of Cuddalore District (where all four villages selected in Ecosystems II and III are located) are vulnerable to inland (from the Cauvery River) and sea water flooding. Sea water inundation is leading to salinisation of soil and groundwater and the situation is likely to continue because of the complete lack of drainage over a large stretch of land in the Cauvery delta. The farmers say that even though normal rainfall in Nagappattinam District is only 970 mm, lack of drainage and sea water flooding gives the impression of very heavy rainfall. Since several parts of this district are below sea-level, the flooding damage is serious

MAP 3 | Pushpavanam village

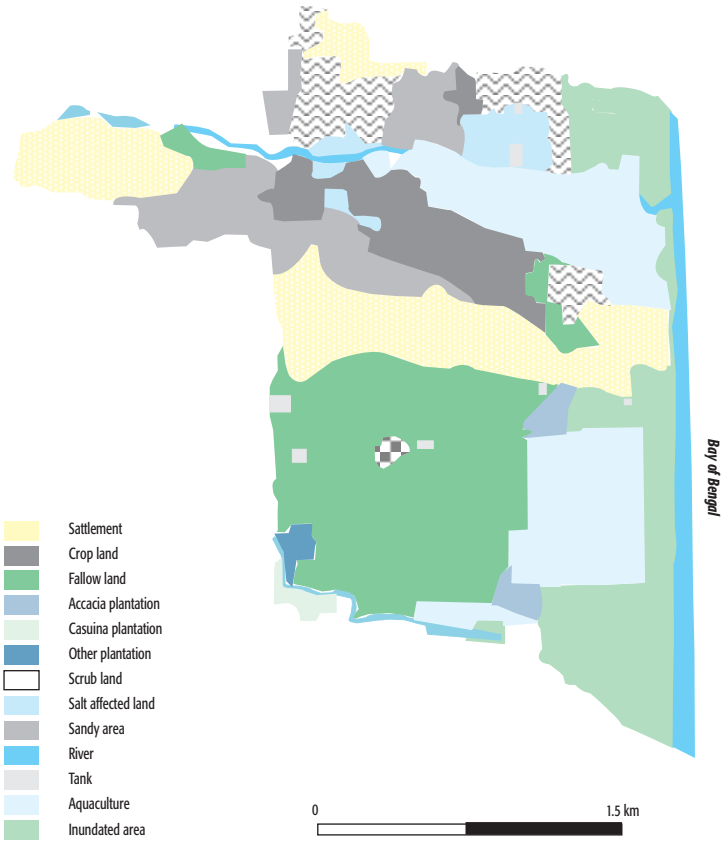


Drainage congestion and floods add to poverty and food insecurity. The absence of access to credit means that people have nothing to hedge against these debilitating factors, and this adds to their stress. People are forced to migrate and seek livelihoods in casual employment. In particular, the most affected are the landless agricultural labourers and small and marginal farmers, comprising about 85% of the total agricultural population in Nagappattinam District.[9] Because they belong to deprived castes, the situation is more serious. Money lenders charge interest rates of up to 120% per year and further exploit the situation.

Inundation by sea water is leading to salinisation of soil and groundwater.

Vanagiri (Ecosystem II): 7,292 people live in 1,623 households distributed over 9 hamlets. There is very little diversification of livelihood in Vanagiri:

MAP 4 | Vanagiri village



Money lenders charge interest rates of up to 120% per year and further exploit the situation.

over 90% of the population is engaged in the traditional livelihoods of farming, dairy or fishing, 8% are landless agricultural labourers and 0.7% are wholesale fish merchants. Fully 374 households in this village are headed by women (widows), over half of which belong to the fishing community. This attests to the fact that the mortality rate among fishermen is high. About 50% of the agricultural land has turned saline or brackish.

TS Pettai (Ecosystem II): 41% of the people of TS Pettai are farmers who also engage in non-farm activities, 16% are landless agricultural labourers who also engage in non-farm activities, and 43% are fishermen and also engage in non-fishing activities such as construction. About 20 people from this village work in Singapore, Saudi Arabia or Dubai, indicating that there is some diversification of livelihood. About 120 men also seasonally migrate to Kerala for agricultural work and fifty families have settled in Ahmedabad, working in an asbestos cement factory. In addition, many have become construction workers and traders. This diversification in livelihood has resulted in a shortage of agricultural labourers in TS Pettai.

Pitchavaram (Ecosystem II): This village is known for its mangrove forests, governed by the forest department. The village has six hamlets with a total population of just over 5,000. There is less livelihood diversification here than in TS Pettai: farmers make up over 60% of the population, landless agricultural labourers 15%, construction workers (and other non-farm livelihoods) 15%, with small businessmen, fishermen and traders making up the rest. 75% of the agricultural land has turned saline or brackish due to sea water ingress.

Pushpavanam (Ecosystem III): Unlike the three other villages, Pushpavanam is a dry village with no access to irrigation. The majority of the population is either farmers (38%) or landless agricultural labourers (42%), while 9% are fishermen and the rest small traders or construction workers. 68% of the households live below the poverty line. Paddy is the main crop which is grown using the broadcasting method. This village is surrounded by backwater

[9] Based on the study by NCRC

rivers on three sides and by the Bay of Bengal on the fourth side. Both drought and flood affect the village. Excessive heat and drought conditions create a famine-like situation. Cyclonic rainfall brings floods and destroys huts. With each cyclone, sea water ingress contributes to salinisation of the land and groundwater.

The monsoon is erratic and rainfall untimely. In the past, the Aadi (mid-June) rain was accurate and timely, helping the broadcast method of sowing. But in the last 10 years, there is either no or uncertain rainfall in the month of Aadi. In addition, the north-east monsoon brings excessive rainfall in a few days, flooding the land. This is true of all other villages selected for this study.

Shared Learning Dialogue and Vulnerability Analysis

Shared Learning Dialogue (SLD)

The emerging climate change context warrants a community-based approach for gathering information and offering risk reduction strategies – both in the short and long run. Furthermore, information gathered through research from various sources should be disseminated to community members through a two-way dialogue. The unique feature of shared learning dialogues is that it is an interactive exercise involving various stakeholders / agencies such as government, private sector, non-government and community members. The process provides a platform for sharing information so that the approach to DRR can be broadened through wider participation. SLDs are an effective methodology for scoping, designing and implementing of adaptive strategies.

SLDs for this research were organised at various levels. First a series of SLDs at the village level were organised with various socio-economic groups; the number of participants varied between four and 20. With each round of SLD, as new insights emerged, new questions were added and others dropped. Second, at district level SLDs, insights gained from village level SLDs were shared.

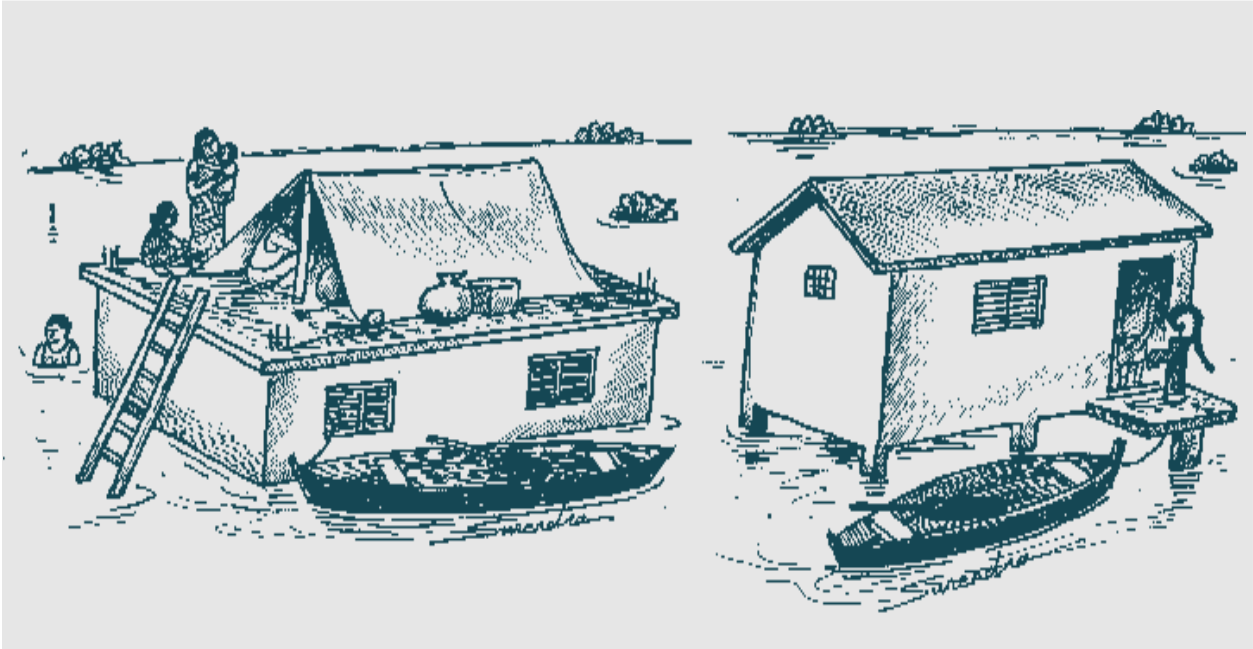
Key issues discussed and information gathered at village level SLDs are used to understand the sequence of disasters and level of vulnerability of different socio-economic groups. They are also used to better understand the behaviour of monsoons, changes in agricultural seasons, crop patterns and productivity, poverty and inequality, demographic characteristics and changes in occupational characteristics. Other insights gained include factors that constrain occupational mobility, asset ownership and losses due to disasters, the coping strategies in times of disaster and the responses of NGOs and governments, local knowledge of weather, modes of communication and necessary early warning systems. The details concerning community-based organisation, measures needed to strengthen them and factors contribute to the safety of those unaffected by disasters were also obtained. Insights gathered were used to understand the specific vulnerability and develop strategies for risk reduction.

Shared learning dialogues are an effective method for scoping, designing and implementing of adaptive strategies.

Participants at the district level SLDs included the district disaster management officer, officials from the fire service, forest department and

Insights gathered were used to understand the specific vulnerability and develop strategies for risk reduction

insurance companies, an officer from NABARD (The National Bank for Agriculture and Rural Development), a soil scientist from the agricultural research center, the director of the Coordination and Resource Center at Nagappatinam, several NGOs, a local cable television operator, mobile operators, farmers and fishermen and women from self-help groups (SHGs). Altogether, forty participants attended the day-long workshop. Insights gathered from these SLDs were taken to the state level SLDs attended by state level officers such as the Relief Commissioner, Revenue Secretary, officials from the meteorology department, officers from insurance groups and banks, NGOs, researchers, state level and district level fishermen and farmers' leaders. The number of participants varied from 2 to 30. Discussions at all SLDs at all levels were recorded and transcribed in Tamil and translated into English for information sharing.



Key Issues

This mix of ideas, in effect, represents a starting point for evolving common understanding of both emerging problems and potential response strategies.

As illustrated by the bullet points below, many issues were raised in the district and state level SLDs. These issues, as might be expected in an initial meeting on climate change and the anticipated impacts in coastal regions, touched on a very wide range of problems and local perceptions regarding potential solutions. What is most important to recognise from the points raised is the mix of conventional "solutions" to emerging problems (people, for example, often called for embankments to protect coastal regions) and more innovative, locally-tailored strategies. The discussions also identified many of the limitations associated with current strategies. This mix of ideas, in effect, represents a starting point for evolving common understanding of both emerging problems and potential response strategies.

District Level SLD

- Inundation has lead to chronic salinity of soil and groundwater, and lack of drainage is the major source of vulnerability in a large portion of the Cauvery delta.
- Thalaignanirru is below sea-level. The 27 rivers in this district are flood carriers.
- Agricultural yield and production has come down by at least 50% due to the impacts of cyclones, sea water and fresh water floods, and land and groundwater salinity.
- Floods and cyclones are annual phenomena but to what extent local administrative measures are capable of handling these disasters in a sustainable manner is a question without easy answers.
- To avoid inundation on agricultural land, farmers suggested that Tail End Regulators be constructed on streams where they meet the ocean.
- Farmers also suggested that bunds on both sides of the Cauvery drainage rivers should be strengthened with appropriate control structures. Other suggestions to directly control the impact of storms included: (1) desilt drainage channels, strengthen bunds, create new canals, bed dam to save water; (2) sand dunes need to be protected (at the moment they are being destroyed) and (3) tanks need to be de-silted and drainage improved.
- In response to the impact of storms and the Asian Tsunami, there was substantial discussion regarding the kinds of houses that should be constructed for people who live close to the sea. Reinforced cement concrete (RCC) construction is not good enough since the steel corrodes quickly. Many suggested tiled houses to cope with the corrosion problem; but a few also argued that from the point of view of coping with cyclones and high-speed winds, RCC houses are far better.
- In order to respond to land and groundwater salinity problems, the development of new farming systems is necessary. People should explore the possibility of cultivating salt resistant crops. Traditional

varieties of paddy are more suitable for salt water. One should explore all possible indigenous technologies to combat and remove the salinity problem in the Nagappattinam District.

- The absence of access to credit for vulnerable fishing and farming groups during times of distress (following storms or droughts) was identified as a major constraint in their recovery.
- Lack of drinking water and sanitation was identified as a major factor accentuating the impact of disasters.
- The unavailability of accurate weather predictions was expressed as a major concern particularly for fishing communities. Existing weather information is considered inaccurate. Only obvious warnings at obvious times are issued. Timely and accurate predictions are necessary to help the fishing population that depends on local knowledge for 90% of its weather forecast needs.
- The creation of a separate fishing cooperative society similar to the existing agricultural cooperative societies was demanded as a key element that would help fishing communities meet both immediate needs and respond to the impacts of climate related disasters.
- Available insurance coverage is viewed as very restrictive. A much broader insurance coverage for both fishermen and farmers was sought as a key element that would assist them in dealing with climate risks.
- Farmers and fishermen expressed concern about the viability of existing livelihoods. As a result, capacity building for better livelihoods and greater mobility in non-fishing and non-farm activites were demanded.

The unavailability of accurate weather predictions is a major concern for fishing communities.

- Where responses to the Asian tsunami are concerned, fishermen have been affected due to excessive distribution of boats in each village as part of the recovery effort. Traditional methods using catamarans produced good fish catches in comparison to current methods. Fish stocks are declining due to intensive and competitive fishing using modern boats and nets.
- In response to depleting fishing stocks, the fishermen debated increasing incubation periods from the current 45 days to sixty days. Such strategies were discussed as important both in response to current declining stocks and the sustainability of fishing livelihoods as part of responses to climate change.
- In response to the Asian tsunami, there was substantial debate regarding compensation policies. There was particular focus on the asset based compensation package that has been promoted and whether or not it solves medium-term and long-term problems. Though controversial, many still supported asset based compensation
- Partnerships between NGOs and the government has been rewarding.

State Level SLD

Key issues emerging from the SLDs conducted at lower levels were discussed at the state level SLD. The state level SLD (a one-day workshop) was attended by state level officers such as the Relief Commissioner, Revenue Secretary, officials from the meteorology department, officers from insurance groups and banks, NGOs, researchers, state level and district level fishermen and farmers' leaders.

Key issues discussed at the state level SLD were:

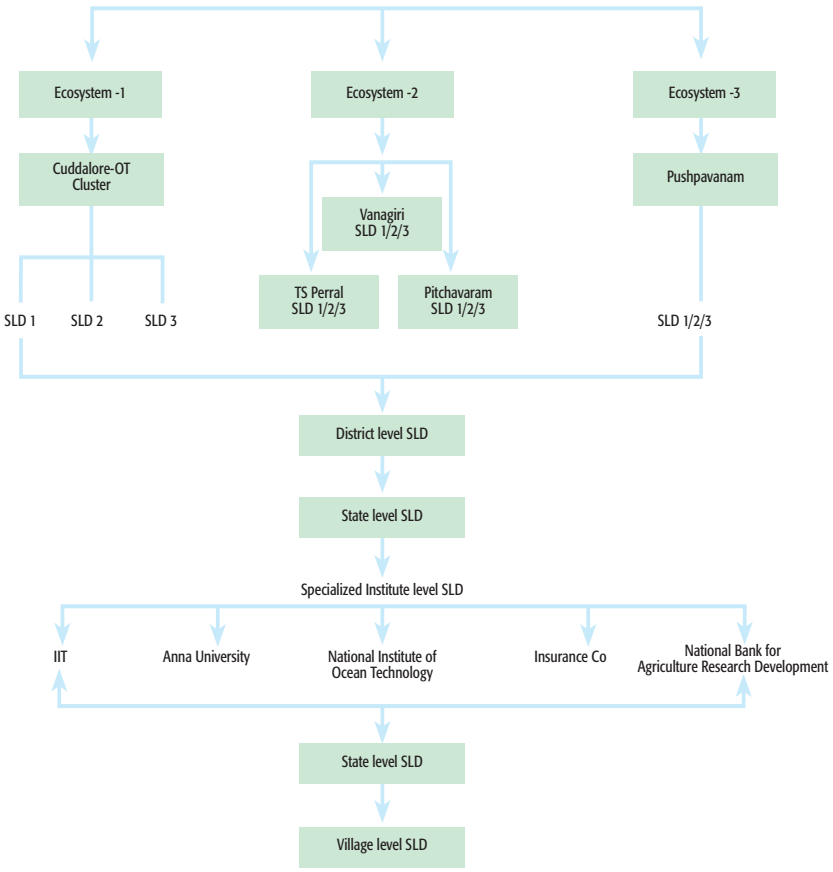
- The community's experiences in handling or responding to coastal extreme events such as storms, floods and tsunamis.
- The community's collective strengths and weaknesses, and the prevalence of community organisations and their strengths.
- The evolution of adaptation strategies undertaken by the community over a period of time.
- Local knowledge in disaster preparedness, early warnings and disaster mitigation.
- The strengths and weaknesses of the community in relation to opportunities and threats confronted.

Further, the following issues in relation to adaptation were discussed:

- What kind of adaptation policy and framework should there be for the immediate, medium and long term.
- How to integrate adaptation in key policy-making and planning process.
- How to make the adaptation policy framework proactive and ensure risk management is from the bottom up.
- How to engage all concerned stakeholders in the decision-making.

Farmers and fishermen expressed concern about the viability of their existing livelihoods.

FIGURE 1 | SLDs at different levels



Analysis of SLD Results

Discussions at the district and state level SLDs identified issues and potential response strategies that in some cases reflect the standard water control measures already in practice and in other cases offer new alternatives. As might be expected, discussions on salinity and the impact of storms initially led to calls for the construction of tidal regulators. Several such regulators have been constructed in the area over recent decades. They are, as a result, already a known and accepted feature that people are well aware of. However, many of the existing regulators are in poor shape and, whether or not this would actually help control salinity, reconstruction would be a clear and tangible activity.

The formation of cooperative societies for fishermen, for example, responds primarily to a current need.

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Floods in Cauvery River 2005

As discussions progressed, a wider array of issues and response strategies were raised. From purely structural control, discussions moved onto livelihoods. Issues related to the sustainability of fisheries and the tolerance to salinity in agricultural systems, for example, are potential points of entry for adaptive changes to existing livelihoods as opposed to measures to protect existing ones. As a result, the SLDs represented a starting point for identifying very practical courses of action that could assist local communities in dealing with both existing problems and the emerging consequences of climate change. Some of the actions proposed appear at a first to be removed from issues of climate adaptation, but could ultimately prove pivotal. The formation of cooperative societies for fishermen, for example, responds primarily to an immediate need. The formation of such societies that would serve as a nodal point for managing fisheries and introducing new practices as sea-level rise inundates more land could, however, be critical in adaptating to new realities. The ability to organise has, after all, been identified as central to adaptive capacity. As illustrated in Box 2, which details debates over shrimp farming, the problems with intensive use of shallow coastal waters are complex. Organisations that can gradually build the technical and institutional capabilities to overcome such problems are central to the ability of fishing populations to adapt to climate change.

Overall, the SLDs provided a mechanism to start the process of identifying courses of action for responding to climate change and other hazards in ways that reflect the insights of both local communities and external actors. More specifically, the SLDs resulted in the identification of key

BOX2 **The shrimp farming debate**

Intensive use of shallow backwater and coastal marine resources is seen by many as a core need in responding to the sea-level rise that is likely to occur as a result of climate change. As the discussion below on shrimp farming illustrates, however, the development of sustainable systems faces major challenges.

In 1991, a company called Fencer Eral first started shrimp farming in 100 acres of wetland in Vanagiri, one of the study villages. The company bought 80 acres of *Thasil Pannai* and another 20 acres of land. After 10 years, the company incurred losses for various reasons. At present the company has leased the farm out to an individual from Dharmakulam village. There are a few other shrimp farms of between 2 and 9 acres. Many schedule caste farmers have sold their land to shrimp farms because their land and groundwater have turned saline.

Costs and Benefits of shrimp farming in all selected villages:

Stage I Fertile land yields 30 bags (60 kg each) of paddy per acre per season, and, when possible, there two harvests per year.

Stage II When land turns saline, only 15 bags of paddy/acre is produced and only once a year.

Stage III When land was converted into shrimp farming (in 1991) the yield from one acre was 1,000 kg of shrimp with a value of Rs. 400,000 from an initial investment of Rs. 200,000 per acre. However, the harvest value has gone down due to insect attack. Currently, the same initial investment only gives a profit of Rs. 25,000 per acre.

Stage IV What happened to those who sold their lands to shrimp farmers? Most of them did not buy land elsewhere and spent the money either in settling debts or on household needs. They have been forced to turn to farming or non-farm casual work.

One of the most important requirements of shrimp farming is good drainage for discharging effluent and proximity to an inlet to pump brackish water. If these facilities exist, irrespective of land quality, shrimp farmers are willing to pay a good price. Land that is saline but without drainage has very low value.

Overall, shrimp farming does produce high returns from inundated lands – at least initially. As currently practiced, however, it is far from sustainable.

points of vulnerability and a wide range of potential response strategies. Vulnerabilities identified are detailed below and lead into the final section on potential response strategies and their costs and benefits.

Key Points of Vulnerability

Weather Information: Local weather information is the same for all the villages selected for this study. If clouds are moving fast, there could be a cyclone. If there is a high tide out at sea, cyclone or heavy rains are possible. The weather information given by the Indian Meteorological Department is unreliable, untimely and inadequate. Cyclone warnings are issued only when there is a threat of a cyclone hitting the coast with in 48 hours. While cyclones do often hit the coast when a warning has been issued, many do not. Villagers need accurate and timely information regarding the start of the monsoon, daily weather information, the number of rainy days and early warning of cyclones. Currently, people use community television, *panchayat* Tom Tom, cable television or temple bell ringing as communication channels during times of disaster. Other channels on which people rely are Karaikal FM, Kodaikanal FM, other FM radio news, television, newspapers and cable television. Existing access to television and telephone are given in Table 6. However, local knowledge such as cool winds, bird movements, roughness of the sea and cloud clusters seem more reliable for many than the weather bulletins issued by the state meteorological department

Cyclone warnings are issued only when there is a threat of a cyclone hitting the coast within 48 hours.

TABLE 4 | Risks, Short-term and Long-term Coping Strategy and Potential Costs and Benefits of Remedial Measures as Perceived by Different Social Groups.

Village name; Type of the social/ economic group	The most important risks faced by each community, in order of priority	Present coping strategy for each risk factor	Long-term strategies sought	Ranking of remedial measures during SLDs (1=least expensive, 10=most expensive)		
				Cost	Short-term benefit	Long-term benefit
Vanagiri **Social Group 1** SC women , farm labourers, small and marginal farmers	1. Floods 2. Sea water inundation and salinisation of land and groundwater 3. Cyclones and storms	1. Migrating to other villages / towns either for agricultural or non-farm work. 2. Working in Shrimp farming 3. Borrowing money	1. Small shutters 2. Concrete sea wall 3. Cyclone shelter 4. Mangrove forest	6 10 7 7	8 9 7 9	8 10 5 10
Social Group 2 Fishing population	1. Cyclones 2. Floods 3. Rough seas 4. Trawlers	1. Seeking temporary shelter in schools 2. Borrowing money 3. Government hand-outs	1. Cyclone shelter 2. Concrete sea wall 3. Community radio 4. Mangrove forest 5 VIC	8 10 4 6 5	8 10 9 10 5	10 10 7 10 8
Social Group 3 Non-SC small farmers / (men and women)	1. Floods in the Cauvery and the untimely availability of water 2. Sea water flooding and salinisation of land and groundwater 3. Cyclones 4. Lack of sanitation	1. Seeking non-farm work and migration 2. Growing alternative crops 3. Borrowing from money lenders	1. Three tail-end regulators 2. Government should ensure water supply to tail-end villages first 3. Strengthen banks of backwater rivers 4. Protecting waterways and lagoons 5 Removing salinity on the land	8 8 5 6	8 10 6 10	9 10 8 10
Pushpavanam **Social group 1** SC labourers and farmers	1. Sea water inundation 2. Droughts 3. Flooding in the backwater rivers	1. Seeking non-farm work and migration 2. Working in shrimp farms 3. Borrowing money	1. Build a series of tail-end regulators 2. Training for non-farm jobs 3. Silt removal from the drainage rivers	8 6 7	6 10 10	9 10 10
Social group 2 Farmers belonging to backward castes	1. Sea water inundation 2. Droughts 3. Floods	1. Migrating to other villages / districts for agricultural or other work 2. Borrowing money from others 3. Breeding sheep	1. Small shutters 2. Try to get Cauvery River water for irrigation which can also reduce soil salinity 3. Desilt the drainage canals	7 10 8	5 7 6	8 8 10
Pushpavanam **Social group 3** Fishing population	1. Cyclones 2. Flooding in the backwater rivers 3. Rough Seas	1. Seeking temporary shelter in schools and govt. relief measures 2. Borrowing money 3. Borrowing money	1. Cyclone relief shelter 2. Mangrove forest 3. Concrete sea wall	8 8 10	10 10 10	10 10 10
TS Pettai **Social group 1** Small and marginal farmers	1. Salinisation of land and groundwater due to sea water floods 2. Droughts 3. Cyclones	Migration and seeking non-farm jobs; a few have tried shrimp farming, unsuccessfully; seeking government support.	1. Shutters in backwater rivers 2. Training for non-farm jobs	5 8	10 10	10 10
Pichavaram **Social group 1** Small and medium farmers	1. Salinisation of land and groundwater due to sea water floods 2. Droughts 3. Lack of sanitation	1. Growing alternative crops 2. Migrating to towns and cities to seek construction work	1. Shutters 2. Strengthening river bunds 3. Desilting and strengthening backwater rivers	5 10 7	10 10 10	10 10 10

After the tsunami, a Village Information Center (VIC) was started in Vanagiri with internet connection for access to daily news and weather information announced (three times a day) through a public address system. DHAN Foundation runs a community radio in Vanagiri but people have no knowledge about this station. Both farmers and fishermen report that Karaikal FM is useful and informative. DHAN Foundation has also started a VIC in Pushpavanam village also transmitting news and weather information three times a day through public address system.

Insurance: Very few people have any life insurance. Most do not pay the premiums regularly. In Pushpavanam, however, 50% of people do have life insurance policies and regularly pay their premiums. There are three life insurance agents residing in this village. Crop insurance is possible only if money is borrowed from the agricultural cooperative society for the main crop grown during the samba season. However, in all the villages, the samba season is non-existant due to changes in irrigation patterns and the late arrival of Cauvery River water. As a result, most farmers cannot get a loan from the agricultural cooperative society or buy crop insurance.

Asset Loss: In each cyclone period, the boats and nets of the fishing population are seriously damaged. Each fisherman spends a minimum of Rs. 20,000 for repairs, borrowed from money lenders and wholesale fish merchants at high interest rates. As a result, in each village close to 25% of fishermen are in perpetual indebtedness. During every cyclone period hundreds of huts are destroyed, the total loss ranging from Rs. 50,000.00 to Rs.100,000.00 per village depending on the intensity of the cyclone. Although many concrete houses were built after the tsunami, hundreds of huts are threatened by cyclones. Hundreds of nets, boats and catamarans need additional heavy investments for replacements and repairs. Total asset losses range from Rs. 2 to 10 lakhs (1 lakh = 100,000) depending on the severity of the cyclone. On average, during each cyclone year, one fisherman borrows up to Rs. 4,000 or Rs. 5,000 for repairs and

Backwater river in Cuddalore OT

Inundated land in TS Pettai

replacements. In some cases, they borrow up to Rs. 20,000.

Livestock: Cyclones cause loss of livestock and chicken. The average loss per household is around Rs.500.

Damage to crops: Most cyclones and floods result in total loss of crops. The loss per acre is in the order of Rs. 2,500 to Rs. 3,500.

Drinking water supply: Drinking water supply is disrupted during floods, cyclones and droughts. The disruption poses a constant threat to livelihoods.

Hundreds of nets, boats and catamarans need heavy investments for replacements and repairs.

Sanitation: Only a few households have toilets and a majority of people defecate in the open. The most affected are women and teenage girls who are forced to walk for miles, even at night, to find privacy. Rape and sexual abuse happens but is rarely reported. Furthermore, finding open space for defecation has become more difficult since the boom in house construction after the tsunami when the government freely distributed land to the landless. Women of Vanagiri, Pitchavaram and TS Pettai villages are demanding toilets.

Land value: Changes in land value (gain or loss) over a period of 20 years gives a reasonably good picture of the vulnerability farmers face. In almost all selected villages, the value of land has steeply declined due to salinisation and flooding. However, even saline land is sold for shrimp farmers for a good price, but only if such plots have an inlet for pumping brackish water in and an outlet for draining effluent out. The plots located close to backwater rivers are preferred for shrimp farming (see Table 5).

TABLE 5 | Changes in the Value of Land per Acre in (Rs)

Village	Land/acre			Acres of land sold to shrimp farming	
	Value 20 years ago	Current value of unaffected land	Current value of saline land	Near backwater	Far from backwater
Vanagiri	20,000	100,000	5,000	60,000	30,000
Pushpavanam	80,000	150,000	50,000	1,75,000	100,000
Pitchavaramn and TS Pettai	25,000	100,000	15,000	100,000	Demand for shrimp farming decreasing so no value here

Strategies Identified

Our analysis of potential strategies starts with the current coping mechanisms that people use to overcome vulnerabilities outlined above. These existing strategies represent key points of entry for bringing together external and internal perspectives on adaptation to hazards and climate risks in coastal areas.

Fisher Community

People are increasingly interested in getting their children educated. The level of literacy has gone up over the last two decades; school enrolment figures confirm this trend. People also express interest in changing occupation but feel constrained because they lack the skills. Still, a good number of young people have migrated to towns and cities; some even to Middle East countries and Malaysia, working in the construction industry, cleaning toilets, rearing camels, laying roads and as servants. It is said that they are heavily in debt and unable to send money to their dependents back home. Hundreds of people are cheated by recruiting agents.

Fishermen in action in anchored boats

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During lean periods almost all fisherfolk borrow money from any available source (money lenders, pawnbrokers and mortgaging of jewels). They also borrow from friends and relatives. Some depend on remittances from relatives working in cities. Worst, small fish vendors (mostly widows who turn to small fish business after they lose their husbands) borrow at interest rates up to 120 % per annum from *thandal* (specialised money lenders living in towns whose targeted customers are small and marginal fishermen, small business people etc.). Borrowing money is a standard coping mechanism.

Everybody buys rice at a subsidised price of Rs. 2 per kg which is considered a big boon. On average, each person consumes 750 grams of rice a day. Suji and wheat are also purchased at a subsidised price. During lean seasons, many people go without food for many days.

During times of heavy floods and cyclones, people move to school buildings or cyclone relief centres. After the tsunami the use of mobile phones substantially increased. However, it was reported that small scale fishermen (who use fibre boats or catamarans) cannot use mobile phones while at sea because the phones get wet. But for

those using trawlers, mobile phones are useful.

Strengthening Village Level Organisations

Informal associations among fishing villages is an integral part of social life. These local level institutions play a crucial role during times of distress. The associations are generally headed by wealthier fishermen with better access to communication. These fishermen are articulate and possess organisational skills and some political clout. These associations exist alongside formal *panchayats*. These informal mechanisms are more powerful with office bearers such as a president, secretary and treasurer to safeguard funds collected from members and to strengthen the association. This money is used during festivals and after cyclones and other disasters for feeding the local community. Fights, heated arguments and even violent actions seem to be a standard feature in fishing communities (within as well as between villages). On the other hand, unity is common too. Orders from the *panchayat* are respected. Many informal associations have savings ranging from Rs.25,000 to a few hundred thousands rupees. One of the main functions of the *panchayat* (formal or informal) is to settle local disputes. The *panchayat* also protects the members and their families from any kind of outside disturbances. The *panchayat* is empowered to exercise actions to punish those who violate rules. The fine ranges from one rupee to Rs.1,000 depending on the nature of the violation.

Local level institutions play a crucial role during times of distress.

The most important aspect of the informal *panchayat* is its organised, collective capacity to cope and bargain with outsiders, including government

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SLD in progress in TS Pettai

officials, during times of cyclone relief distribution, which was well demonstrated in the post tsunami period. But they still lack the capacity to deliver relief and rehabilitation support. Their capacity needs to be strengthened through access to better information on weather and climate. Fishermen in backwater regions are considered inferior to marine fishermen. They may not become members of the informal *panchayat*, and there are no efforts to help them organise. There is, however, no animosity between these two groups.

During the post tsunami period, a separate committee was formed in many villages to coordinate the relief and rehabilitation work in the hamlets. Cases of mismanagement of relief aid have been reported. Some openly criticise this corruption during meetings, but others negotiate with the committee for personal gains. In some cases, villagers have jailed Tsunami Relief Committee Members (who are part of village *panchayats*) for mishandling tsunami relief resources.

Farming Communities in Ecosystems II and III

Schedule caste people, landless agricultural labourers and small and marginal farmers (who are most severely affected by coastal hazards, floods in the Cauvery River or erratic drought conditions) keep migrating, daily, seasonally or permanently. Many have migrated to Kerala, Bangalore and Gujarat, taking up all kinds of non-farm jobs. But most of them work as construction labourers. In TS Pettai and Pitchavaram, about 80% of small and marginal farmers seek jobs in construction. To a lesser extent migration also takes place out of Vanagiri and Pushpavanam. The state government has begun issuing social security cards to those living below the poverty line. The card is expected to help them obtain assistance for marriages, compensation in cases of accidental death, assistance to meet funeral expenses, assistance during pregnancy and abortions, education subsidies for dependent children, and old-age pensions. A large number, however, borrow from friends and relatives and mostly from money lenders. In recent years, rice has been sold at Rs.2 per kg and each family card-holder is eligible to buy 20 kg of rice per month. This arrangement helps daily wage earners and small and marginal farmers to survive during time of drought and flood. Most importantly, self-help groups provide support for these very poor people who otherwise depend on money lenders to meet their financial needs.

Local institutions lack capacity to deliver relief and rehabilitation support.

Due to inundation from sea water and the resulting salinity, many farmers have shifted to salt and flood resistant varieties of paddy such as *kar and uyyakondan*. Many others have shifted to coconut, casurina and mango plantation. Saltwater intrusion affects plots near the Uppanaru River. Shrimp farming on poramboke land (government land) has also contributed to salinity, which has forced landowners along the river to either convert to shrimp farming or sell their land to shrimp farmers. Converting to shrimp farming appears to be an alternative livelihood in salt affected areas, but small and marginal landholders cannot withstand both the initial investment and high maintenance cost involved in shrimp farming. Farmers who have sold lands to outsiders for shrimp farming have spent the money in meeting household

and health expenses. They end up being landless labourers.

Irrespective of whether the livelihood is fishing or agricultural, coping mechanisms and strategies depend on the facilities available in the villages (see Table 6).

Strategies Identified

Affected people have expressed innovative strategies which could form a part of a long-term adaptive strategy plan, although the preference is for 'structural' strategies. One example is the fishermen's demand for cold storage facilities to store fish and be able to sell them at a later date. They also demand good drinking water and sanitation facilities. Other expressed needs are prevention of pollution in backwater rivers and better housing. Similarly, most people among the farming communities mentioned that shutters in various backwater rivers would prevent mixing of sea water with freshwater. They also argued that the shutters would prevent periodic flooding of

TABLE 6 | Facilities Available

Type of infrastructural facility	Vanagiri	TS Pettai	Pitchavaram	Pushpavanam
panchayat office	1	1	1	1
Community hall	2	1	1	6
Library	2	1	1	1
Ration shop	2	1	2	2
Noon-meal center for children	2	1	2	2
Day care center: Government	2	1	3	2
NGO	0		1	3
Drinking water: Public taps	70	20	52	
Hand pumps	43	8	53	188
Private taps	46	30	60	0
Overhead tanks	7	1	4	2
Primary health center	2	1 (unused)	1	2
Wireless and public address system	1	1	1	1
Schools: Primary School	2	1	3	5
Middle School	3	0	0	1
High School	0	1	0	1
Private School	3	0	0	1
Telephones: Landline	120	0	0	963
WIL Phone	60	55	35	0
Mobile	1108	125	150	1105
Public booth	2	1	6	50
Electricity connection	90%	90%	90%	80%
Type of houses: Terrace	129	40	26	77
Tiled	265	75	121	150
Colony houses	494	100	47	226
Huts	735	10	664	1468
Toilets Public	1	1-unused	1	2 (unused)
Private	722	50	240	705
Television with cable connection or DTH	1200	100	250	500
Public television	2	1	2	6
Post office	1	0	1	1
Cyclone relief center	0	1	1	1
Bus service	Yes	Yes	Yes	Yes
Cooperative Society	1	1	2	2
Number of NGOs operating	10	3	6	12
Meeting hall for self-help groups (SHG)	2	0	1	1
Number of SHGs: Women	30	22	38	58
Men	5	0	6	12
Village Information Centre	1	0	0	2

agricultural lands from sea water. In Pushpavanam village, many people mentioned that they needed either community wells or private wells. All these measures would definitely enhance the capacity of the community to better adapt in extreme climate conditions but will not help to overcome the risks posed by long-term impacts due to climate change. These interventions appear ad hoc in nature and may not contribute to long-term adaptive strategies.

Overall perception of risks, vulnerabilities and local needs in all ecosystems are summarised as follows:

Floods in Cauvery River 2005

1. Cyclones and Storms

Populations most affected: Fishing communities and some others
Vulnerability level: Very high
Risk factors: High wind speeds with heavy rainfall; flooding; sea water ingress
Asset loss: Extensive damage to huts and semi-roof dwellings, to livestock and poultry, to boats and fishing nets; loss of land; loss of livehoods
Coping strategies: Temporary move to cyclone shelters or schools; financial loans; reliance on government support and NGOs; support from self-help groups
Existing government support: Ad hoc cash support, provision of 10 kilos of rice, 10 liters of kerosene, one dhoti (traditional Indian man's trousers) and one sari (traditional Indian woman's dress). No long-term adaptation plan whatsoever.
Potential impacts of climate change: Already serious and likely to be aggravated. Vanagiri village has lost developed land to sea water ingress. Sea water has encroached on at least 800m of land in all villages.

Sea water encroachment is increasing.

Individual debt has gone up with the increasing frequency of cyclones and droughts.
Climate change risk awareness: Some fishermen are aware of the threat of climate change, but the majority of people are not, despite seeing changes in weather and monsoon patterns, erratic rainfall, sea water ingress, etc.
Reasons why some populations are unaffected by the impacts of climate change: Concrete homes built on elevated land; better education, including in the English language leading to better jobs; at least one household member engaged in non-fishing livelihood; better drinking water and sanitation; vehicle ownership; access to government officials; greater wealth allowing ownership of trawlers, multiple boats, etc.
Demands of affected populations: Better weather forecast information; a stop to the polluting of backwaters and the sea; skills acquisition in non-

fishing activities such as carpentry, masonry, construction, electronics and electrical engineering, etc.; mangrove and coconut plantation and stonewall protection from sea surges; cheaper credit. Most women need better sanitation, drinking water and healthcare.

2. Cauvery and Sea water Floods Contributing to Land and Groundwater Salinisation

Populations most affected: Small and medium farmers (and some others)
Vulnerability level: very high
Risk factors: Inundation; land remaining fallow due to salinity; very poor crop yield; decreased land value
Asset loss: Decreased land value; total loss of groundwater due to salinisation; loss of agricultural production and employment
Coping strategies: Out-migration for non-farm jobs in towns, shrimp farming, borrowing money, sheep breeding, support from self-help groups
Existing government support: None
Potential impacts of climate change: Already serious and likely to be aggravated; hundreds of people have already lost their livelihoods
Climate change risk awareness: None
Reasons why some populations are unaffected by the impacts of climate change: Ownership of land in elevated areas or at least two kilometers inland; better education; non-farm livelihoods; remittances from abroad; credit worthiness and the capacity to take loans; self-employment (self-employed people are relatively better-off, both economically and socially).
Demands of affected populations: Among young men: skill acquisition in industrial trades (welding, electrical engineering, electronics, etc.) and computer skills. Most farmers want shutters in backwater rivers to prevent further salinisation of land and groundwater. Some farmers want support in obtaining salt resistant crop seeds and in creating a market for salt resistant crops. Here also women need better sanitation and drinking water facilities and credit for sheep breeding.

Most women need better sanitation, drinking water and healthcare.

3. Drought

Populations most affected: Farmers, landless agricultural labourers (and some others)
Vulnerability level: Medium intensity
Risk factors: Excessive heat; poor drinking water supply; poor crop yields; unemployment; lack of fodder; food shortages and hunger
Asset loss: Selling off of livestock, land, jewelry and other household items for income
Coping strategies: Borrowing from money lenders; support from self-help groups; out-migration
Existing government support: Rural employment guarantee scheme for job creation is helpful but very political
Potential impacts of climate change: Loss of livelihoods and worsening food security
Climate change risk awareness: None
Reasons why some populations are unaffected by the impacts of climate change: Assured non-farm employment; supplemental sources of income from trade and business or remittances; ability to borrow large sums of money; better education.

Government and private sector workers tend to be better-off economically and socially.

What affected populations want: Among young men: skills acquisition in industrial trades (welding, electrical engineering, electronics, etc.) and computer skills. Most farmers want shutters in backwater rivers to prevent further salinisation of land and groundwater. Women need better sanitation and drinking water facilities and need to be given official identity cards as belonging to self-help groups in order to easily obtain bank loans. There is strong demand for a drought relief package from the government.

4. Lack of Sanitation and Assured Drinking Water

Populations most affected: Women (in particular teenage girls) and the sick
Vulnerability level: High intensity
Risk factors: Sexual abuse; snake bites; for those who have no toilets, the time taken in having to walk long distances for any privacy; falling sick during drought and flood conditions.
Asset loss: Death from snake bites; poor health and associated medical expenses; loss of valuable time in seeking toilet privacy and fetching safe drinking water
Coping strategies: None
Existing government support: Houses with toilets built after the 2004 tsunami; construction of public toilets for women and children
Potential impacts of climate change: Likely to become a serious issue in the future
Climate change risk awareness: None
Reasons why some populations are unaffected by the impacts of climate change: Ownership of homes with private toilets; ownership of concrete houses
What affected populations want: Continual access to safe drinking water; health care; toilets

Implementation Schemes and Strategies Identified in the SLD Process

For Fisher populations in all Ecosystems

- Except in a few places there is no bio-shield in the villages. Growing mangroves would benefit and even save the fisher communities from extreme weather events. Many people have shown a preference for coconut trees as a bio-shield.
- People need skills training in non-fishing activities such as carpentry, masonry, electrical works, plumbing, heavy vehicle driving, and communication.
- Access to insurance and credit needs to be established
- Training in the fish processing industry such as manufacturing of fish pickles, prawn pickles and tinned fish as well as training in the expert of these products needs to be provided.
- Need better schools and particularly education in the English language
- Everyone appreciated the idea of a community FM station for communicating information during times of disaster
- Safe drinking water is one of the most important demands – the groundwater is saline and polluted.
- VICs are considered a good facility but need to be integrated with

Most people need and want the same basic necessities: skills training in non-farm based livelihoods, access to safe potable water, sanitation facilities.

people's needs and wishes. VICs could be strengthened with the provision of reliable climate information.

- Sponsoring young boys and girls for technical training such as industrial training, computer training, science courses, training in NGO activities and the English language would be of great benefit.

For Agriculture Dependent Populations in all Ecosystems

- Skills training in non-farm livelihoods such as industrial trades (fitter, welder), carpentry, masonry, plumbing, electrical and electronics servicing.
- Sheep breeding, dairy production and growing fodder (which can be grown on saline land). Subapul, for example, is a salt resistant crop which is also a fodder. Several other crops could be grown in brackish water and used as animal fodder. Sheep breeders are less affected by the impacts of climate change
- Poultry farming
- Training in brackish water shrimp and fish farming
- Sponsoring young boys and girls for industrial training, computer training, science courses, training in NGO activities, English language courses, etc.

- VIC and FM radio services
- Better library with Tamil and English newspapers for information on education and employment opportunities.

Cost-Benefit Ranking of Response Strategies

In order to prioritise discussions within both the district and state level SLDs on the identification of practical strategies for responding to risks and vulnerabilities, a cost-benefit ranking exercise was carried out. Potential costs and benefits were ranked in the range of 1 and 10, in which 1 referred to the least and 10 to the highest cost. Similarly, potential benefits were also ranked between 1 to 10. For example, if the cost of a particular strategy was ranked 9 and the potential benefit was ranked 3, then the strategy would be regarded as a high cost–low benefit strategy. Ideal strategies would cost rank as 4 or below with potential benefits ranking above 7. A series of such exercises were documented, giving insights into the perspective of each community regarding the costs and benefits of strategies to overcome their risks and vulnerabilities (see Table 4).

Conclusions

This case study assessed the nature of existing hazards and vulnerabilities and identified possible adaptive measures in select study villages. Shared learning dialogues were used to understand and analyse the risks and vulnerabilities experienced across different sections of the population. Discussions with government officials, private sector and NGO personnel were held. SLDs were used as a two-way process to identify and discuss the issues. Furthermore, the SLDs were useful for identifing innovative and practical measures for long-term adaptation by the affected communities. Existing adaptation measures undertaken by the communities are ad hoc and not sustainable in the long-term. More SLDs should be organised to clarify practical, long-term, comprehensive and innovative strategies. The communities have agreed that carefully planned adaptive strategies are superior to their current coping mechanisms. There needs to be a continuous exchange of information gathered through this research with government agencies, private service providers, NGOs and those engaged in climate adaptation studies and disaster risk reduction.

There needs to be continious engagement with various stakeholders to identify practical, long-term, comprehensive and innovative strategies for adaptation to climate change.

I am extremely grateful to my project staff for all their support in data collection from both the field as well as the existing literature. In particular, I would like to acknowledge the work carried out by Dr.Geeta Lakshmi and Mr.G.Prabahar. Further, I am indebted to all the respondents in the selected villages who patiently shared their experiences during our field visits.

Appendix 1

Severe Cyclones that hit the Tamilnadu Coast, in Particular the Cuddalore and Nagappattinam Coasts

1. Cyclone Rameswaram, 17th to 24th December 1964, wiped out Dhanuskodi village on Rameswaram Island. A passenger train which left Rameswaram Road station at about midnight on the 22nd was washed away by the storm surges, killing nearly all the passengers. The Pamban bridge connecting Mandapam and Rameswaram Island was also washed away by storm surges 3-5 meters high.

2. December 1st-8th, 1972: A cyclone tracked over the Tamilnadu coast just north of Cuddalore at 2330 UTC on 5th December and was within 50 km WNW of Cuddalore at 0300 UTC on December 6th. Maximum wind speed recorded at Cuddalore was 148 km / h between 2230 UTC of the 5th and 0230 UTC of the 6th of December. 80 people were killed and 30,000 people rendered homeless in Madras due to the resulting flood. Total losses amounted to Rs. 40 crores (1 crore = 10,000,000).

3. November 8th-12th, 1977: A cyclone tracked over the Tamilnadu coast within 10 km of the south of Nagapattinam early in the morning of the 12th around 2230 UTC. The system weakened into a cyclonic storm by that evening over interior parts of Tamilnadu and emerged as a deep depression onto Laccadives off the north Kerala coast on the morning of the 13th. Maximum wind speed recorded was about 120 km / h on the 12th morning at Thanjavur, Tiruchirapalli and Podukottai. 560 people died and 100,000 people lost their homes. 23,000 heads of cattle perished. The total damage to private and public property was estimated at Rs. 155 crores.

4. November 14th-24th, 1978: A cyclone tracked over between Kilakkarai and Rochemary in Ramanatharam District of Tamilnadu on the evening of the 24th as a severe storm emerged off the Arabian Sea on the Kerala coast, emerging as a deep depression on the morning of November 25th. Maximum wind speeds of 145 km / h were reported at Batticola, Sri Lanka. In India, 5,000 huts were damaged; total damage was estimated at Rs. 5 crores. In Sri Lanka, 915 people died and one million people were affected; 10,000 houses were damaged.

5. November 27th-30th, 1984: A cyclone tracked over the southern Tamilnadu coast near Nagapattinam in the afternoon of December 1st near Karaikal. About 35,000 people were affected in East Thanjavur and South Arcot districts. 50, 000 acres of land were submerged in Thanjavur district.

6. 11th-15th November 1991: A cyclone tracked over the Tamilnadu Coast north of Karaikal. 185 people died and 540 heads of cattle perished.

7. 11th-17th November 1992: A cyclone tracked near Tuticorin (Tamilnadu). 175 people died and 160 more were reported missing. The resulting floods caused extensive damage to standing crops.

8. 1st- 4th December 1993: A cyclone tracked north of Karaikal in Tamilnadu, killing 100 people.

9. 28th November-6th December 1996: A cyclone tracked near Chennai around 2100 UTC on December 6th. The cyclone persisted for 9 days, reported to be one of the longest duration stationery cyclones in the Indian Ocean. It caused extensive damage to life and property.

10. Tropical Storm 06B formed 550 nautical miles east of Chennai on December 6th, 2005, west of the Andaman Islands. It became Cyclonic Storm Fanoos on December 7th. Cyclone Fanoos later weakened into a deep depression before crossing the northern Tamilnadu coast near Vedaranyam at 0530 UTC on December 10th. The storm weakened further into a low pressure area over the southern Tamilnadu coast the following day. It caused major floods all over Tamilnadu, in particular the on coastal districts.

Bibliography

Antoinette, L., E. Brenkert and L. Malone, *Vulnerability and Resilience of India and Indian States to Climate Change: a First Order Approximation*, Stratus Consulting Inc. and Global Change Research Institute, College Park, MD.

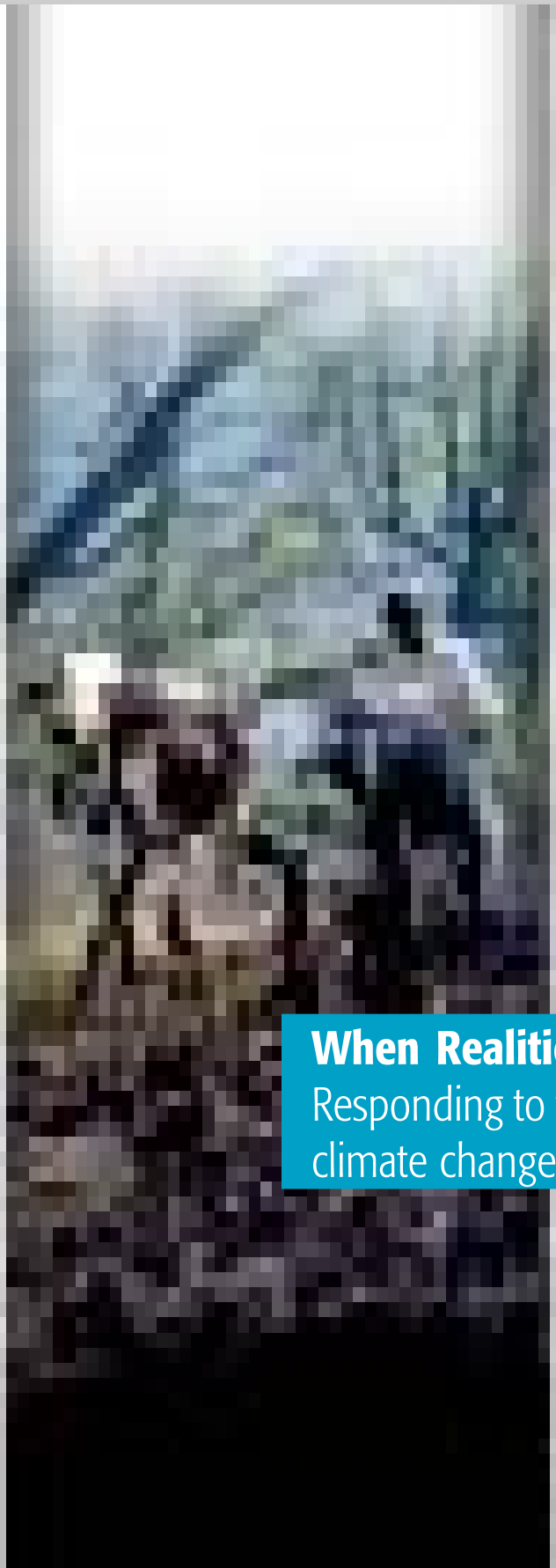
Asian Disaster Preparedness Center (2005), *Country Paper for India*, presented at the International Workshop on Strengthening the Resilience of Local Communities in Coastal Areas, Copenhagen, Nov. 16-18, 2005.

K. S. Kavi Kumar and S. Tholkappain (2006), *Relative Vulnerability of Indian Coastal Districts to Sea-Level Rise and Climate Extremes*, International Review for Environmental Strategies 6 (2).

Janakrajan S. (1999) *Conflict over the invisible resorce in Tamilnadu: Is there a way out in Rethinking the Mosaic, Investigations into local water management,* eds. Moench et al., NWCF and ISET International.

TERI (1996), *The Economic Impact of One Metre Sea Level Rise on Indian Coastline: Methods and Case Studies*, report to the Ford Foundation.

Shrestha, M.L. (1998) (Ed.) *The impact of tropical cyclones on the coastal regions of SAARC countries and theirinfluence in the region*. SAARC Meteorological Research Centre, Agargaon, Bangladesh, 329 pp.14Mani, J.S., 2000. Coastal processes in Tamil Nadu and Kerala: environmental and socioeconomic aspects. In: Environ-mental problems of coastal areas in India, Editor, V.K. Sharma, Bookwell Press, New Delhi, pp. 201-216.



10

CHAPTER

When Realities Shift:
Responding to floods and the challenge of climate change in Ganga Basin

Ajaya Dixit, Marcus Moench and
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The Challenge

Current approaches to flood management are unable to deflect the impacts on human lives and livelihoods.

The annual monsoon floods in the Ganga Basin are essential for preserving fertility of soils, sustaining the ecology, and recharging aquifers. However, they are also often destructive and cause much misery. In 2007, for example, monsoon flooding of the Ganga and its tributaries inundated sizable areas across Nepal, Eastern Uttar Pradesh, Bihar, West Bengal and Bangladesh, killed thousands and displaced millions. Numerous houses and other assets were damaged or destroyed, agricultural losses were considerable, and livelihoods suffered as people lost access to jobs, transportation networks and other sources of wage labour. Furthermore, the prevalence of water-borne diseases, particularly among children, women and other vulnerable groups exacerbated the effect of direct economic losses. In fact, impacts of flooding are widely recognised as a major factor contributing to the endemic poverty of the region. Clearly current approaches to flood management are unable to deflect the impacts on human lives and livelihoods.

The scale of the 2007 flooding could well become the norm across the Ganga Basin if climate change projections prove accurate. The fourth IPCC summary report states about the Himalayan region that "heavy precipitation events, which are very likely to increase in frequency, will augment flood risk." (2007: 7) The report also projects that average precipitation levels in the Ganga Basin will increase by approximately 20% and, at a global level, there will be increases in climatic variability including increases in the frequency and intensity of extreme weather events such as large storms (IPCC, 2007). Flooding in 2007, although not necessarily caused by climate change, is nonetheless consistent with the type of impacts with such projections.

Flooding has a particularly devastating impacts on the 504 million or so who live in the Ganga Basin: 440 million in India, 41 million in Bangladesh and 23 million in Nepal[1] because they are among the poorest in the world and finds it hard to reconstruct livelihoods following a flood disaster. Socially and economically marginalised and asset poor families often have no option other than to live in vulnerable locations such as flood plains, because processes of social and economic exclusion prevent them from owning land in less flood-prone areas. The number of poor and vulnerable families is almost certain to grow as a consequence of climate change.

Throughout most of recent history, governmental strategies for flood mitigation in the Ganga Plain have emphasised structural control measures, primarily embankments, measures, which, as the floods of 2007 demonstrate, have proved inadequate

[1] All 2001 data compiled from various sources.

and in many cases, detrimental. As climate change progresses, these measures will become increasingly ineffective because they do not address the fundamental dynamics of basin hydrology, geomorphology and social contexts. Their inadequacy is likely to increase. Effective alternatives, which include measures to improve drainage, provide points of refuge and improve early warning systems, must be developed. Livelihood systems that have a high level of resilience to the disruptions caused by floods must be built and access to resilient communication, transport and financial systems provided (Moench and Dixit 2004). The region faces a fundamental challenge: develop effective strategies for adapting to impacts of floods or face regular disasters that undermine development and contribute to endemic poverty.

Objectives and Purpose

The objective of this chapter is to document the basic hydrologic and other reasons conventional approaches to flood management have proved insufficient to protect populations in the Ganga Basin and to identify alternative strategies that should help people in adapting to floods. We focus first on the historical and current impacts of flooding and then consider impacts projected to occur as a consequence of climate change. We then briefly explore the history of flood management attempts, focusing primarily on the technical debates regarding viable strategies for flood control. This analysis is used as a basis for identifying potential alternative approaches. The chapter concludes with a preliminary analysis of the flood risk management alternatives designed to provide policy makers and other key actors with an understanding of the challenges and alternative strategies for reducing flood risk and responding to climate change.

Livelihood systems that have a high level of resilience to the disruptions caused by floods must be built .

Flooding in the Ganga Plain

Official figures provide relatively little insight into the multiple factors that contribute to their impact on the health and long-term well-being of the affected populations.

The 2007 flood was above long-term averages but still far from unprecedented. Flooding is so common that over the centuries populations living in the basin have coped with and adapted to both annual patterns of inundation and more extreme flood events. Between 1744 and 1987, 42 major flood events occurred in the Ganga plain (Kale, 1998). Ten such events took place between 1953 and 2007, including those in 1953 (Nepal and Bihar), 1954 (Nepal and Bihar), 1968 (Eastern Nepal, Bihar, Darjeeling and East Pakistan), 1975 (Bihar and West Bengal), 1977 (Bihar and West Bengal), 1987, 1988 (Bangladesh), 1993 (Nepal and Bihar), 1998 (Nepal, Eastern Uttar Pradesh), 2002 (Eastern Uttar Pradesh) and 2007 (Nepal, India and Bangladesh). In addition to regional events, many localised flood disasters occur, but these are neither documented by official sources nor reported in the national media.

The impact major flood events can have is clear from the data collected for the floods this year. In 2007, statistics collected by the Red Cross and other sources indicate that across the Ganga Basin in India, Bangladesh and Nepal about 35 million people were affected, over 1,400 lives were lost and almost 5 million hectares of crops were affected (see Table 1). Even in Nepal, a country few people think of as flood affected, over 580,000 people were affected and 164 lost their lives. As the accompanying map (see Figure 1) illustrates, the impacts of flooding were not confined to the Ganga Basin but extended throughout much of Asia.

The above official figures, although indicative of the extent of flooding, provide relatively little insight into the multiple factors that contribute to their impact on the health and long-term well-being of the affected populations. Official figures aggregate losses and do not tell the individual and community stories of loss, coping, and ripple effects. Flooding affects populations in diverse ways, only some of which are related to immediate losses.

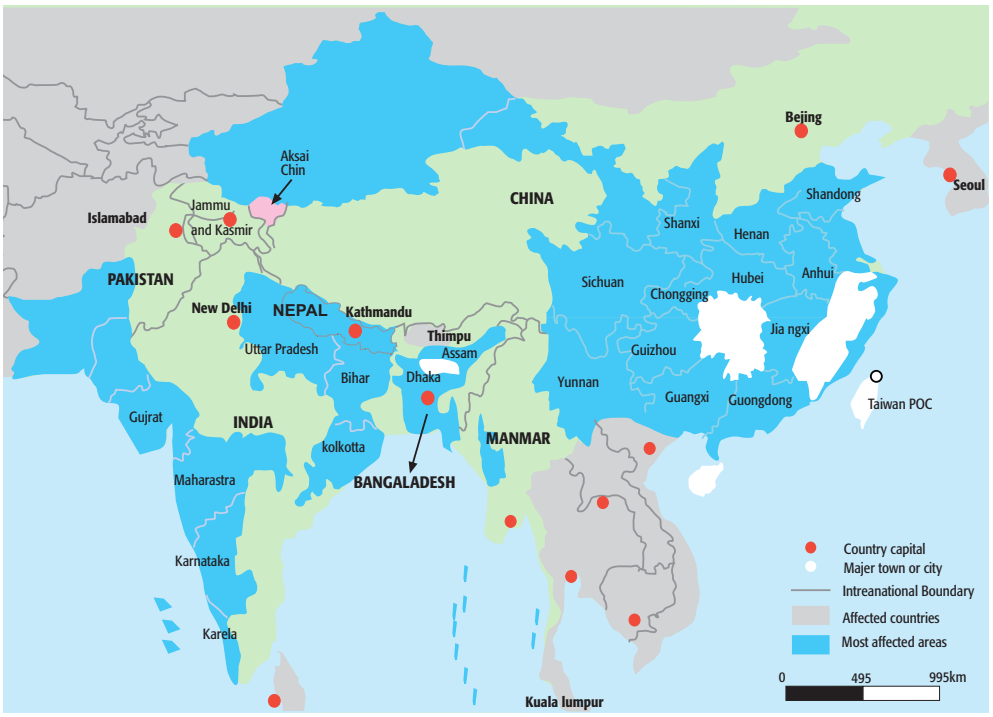
In the immediate term, physical losses such as damage to infrastructure particularly roads and houses, and destruction of resources are readily apparent. In Bihar and Bangladesh, many crops were completely destroyed by floodwaters that covered fields for days because embankments and road

TABLE 1 | Summary of Flood Damage in Ganga Basin

Country	Population Affected	Lives Lost	Districts	245 and 7 Municipalities	Affected Crop Area ha
Nepal					NA
India	580,000	164	49		India
Uttar Pradesh	2,211,000	216	22	2,546	162,566
Bihar	14,420,000	480	20	9,840	1,455,000
West Bengal	6,871,000	212	3	3,837	2,213,150
Bangladesh	10,583,574	363	252	1,955	1,089,959

Source: Indian Government Situation Reports, Bangladeshi Government Situation Reports, Nepal Red Cross Situation Reports (2007).

FIGURE 1 | Area affected by 2007 Floods



Source: UN OCHA Regional Office for Asia Pacific (2007)

networks impeded drainage (Agence France Presse, 2007; Oxfam, 2007). Damage to transportation networks left millions isolated in India, Nepal and Pakistan and made it difficult to convey relief supplies to the flood refugees. Access to food and clean drinking water was so limited that some people resorted to eating rodents (BBC, 2007). As the flood waters receded, outbreaks of cholera and other water-borne disease began to overwhelm some regional relief centers and hospitals in Bangladesh, Uttar Pradesh, Bihar and western Bengal in India (***The Guardian*, 2007).**

The devastation of crops, the loss of livestock, and destruction of personal possessions have long-term livelihood implications for individuals and for economies, at the local, national and regional scales. Individuals without access to credit or livelihood diversification options, such as migration or non-land based income, face the greatest difficulty in rebuilding their lives. Many consume household savings and take out loans, often under usurious terms to buy seed for crops resulting in permanent indebtedness and ultimately increased poverty. In addition because people use migration as a key mechanism for adaptation, socio-economic relationships in regions frequently affected by the adaptation process.

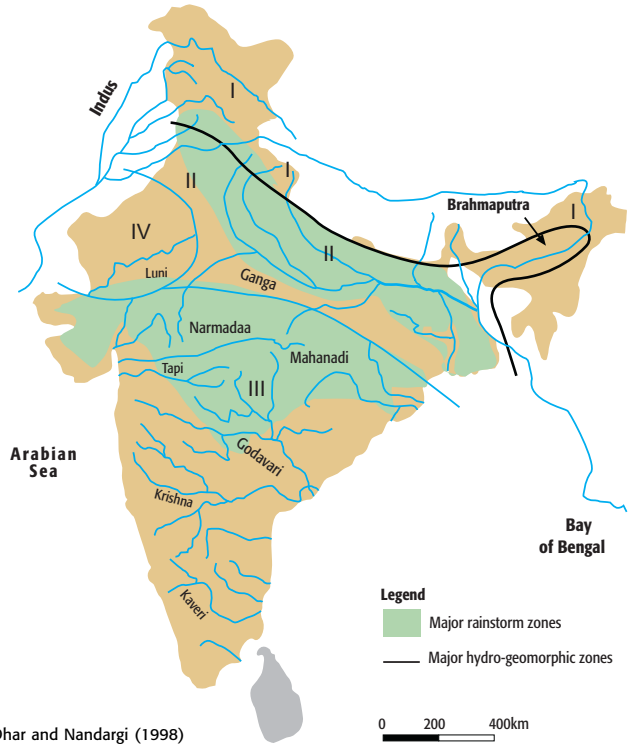
Many consume household savings and take out loans, often under usurious terms to buy seed for crops.

The 2007 floods further highlight the need for disaster risk reduction in development programmes. Without such measures, development and poverty reduction initiatives will continue to face serious and continual setbacks.

The Structure and Hydrology of the Ganga Basin

The South Asian landmass receives most of its precipitation during the summer monsoon season when, as a result, it faces recurrent floods. South Asia has many of the hydro-climatic conditions which make large floods likely (Hayden, 1988 quoted in Kale, 1998). These include two large flood-generating synoptic systems ranging in force from tropical lows to cyclones (Ramaswamy, 1987). According to Dhar and Nandargi (1993) the flood generating rainstorms are confined to two major zones. The Ganga Basin and Punjab plains fall in the first zone while central India and northern half and peninsular India constitutes the second zone (see Figure 2). There is marked spatial and temporal variation in the magnitude, frequency, and duration of floods due to the differences in the size of the catchment, basin relief and basin location with reference to the monsoon winds and cyclone tracks.[2] Other key factors, which exercise important control over river floods in South Asia, include basin geology, morphology, and channel geometry. These natural conditions intertwine with the human built environment of the region, resulting in frequent flood disasters.

FIGURE 2 | Flood Generating Synoptic System over South Asia



Source: Dhar and Nandargi (1998)

In terms of response to high flows and floods, South Asia can be broadly divided into four hydro-geomorphic regions: the Himalayan region, the Indus-Ganga-Brahamaputra plains, the Peninsular region and the Thar Desert. (see Figure 2.)[3] While the above demarcation is useful, it is more logical to consider the Himalaya and southern plain of the Ganga Basin as one region. Because the Himalayan region and its foothills receive high normal precipitation and some of the highest 24-hour rainfall events in South Asia (Rakhecha and Pisharoty, 1996), the Ganga Basin has a greater flood potential than the peninsular rivers. The peak discharges of the Ganga Basin rivers generally occur in late July,

[2] For details see Gupta (1988)

[3] The map and details are from Kale (1998) and Kale (2003)

August and September, when cyclonic activity over the Bay of Bengal and adjoining coastal belt on the Arabian Sea is most vigorous and when high levels of antecedent moisture means that the bulk of the rainfall is converted into runoff. The magnitude, intensity and timing of monsoon rains determine what the peak discharges will be. Early and late monsoon floods, however, are not rare and uncommon. Nor are multiple flood events in a single year, as evidenced by late July and the late August floods in 2007.

Excessive rainfall during the monsoon is associated with particularly intense phases of the monsoonal depression, cyclonic storms originating in the Bay of Bengal and adjoining coastal regions, orographic lifting along mountains and finally with breaks in the monsoon. The last element, breaks in the monsoon, are particularly strongly associated with large-scale flooding. During active breaks, the monsoon trough, which normally falls along a belt via Sri Ganganagar, Patna and Calcutta and brings rain along this low-pressure region, shifts towards the northern foothills and becomes temporarily stationary.[4] When this happens, the hills receive intense rainfall, and the days in the plain are rainless. The oscillation of the trough is regular, often modulated by the Madden-Julian Oscillation (Waliser *et al.*, 2003). (Refer to Chapter 3 for further information on the Asian monsoon). According to Indian weather statistics, the trough can remain in the hills from a minimum of three to four days to a maximum of three weeks.

Although all the rivers of the Ganga Basin receive water from the monsoon, their responses vary depending on their nature, whether mountain-fed, foothills-fed or plain-fed. Mountain-fed rivers receive water from snow and glacier melt in both the dry and wet season. Since they have large catchment areas, monsoon rainfall in conjunction with snowmelt can cause very high flows that contribute to inundation once they reach the plains. Because their discharge and sediment load exhibit large variation, their flood responses are often rapid and widespread. The foothill rivers, which drain the Siwalik (*chure*) range, are rain-fed and often do not flow during dry periods. They are prone to flash flooding triggered by intense cloudbursts. Rivers that originate in the plains derive part of their flow from groundwater. During the monsoon they flow at bank-full conditions for the duration of rainfall and, in combination with groundwater derived base flows, become sources for widespread regional inundation.

Cloudbursts, accentuate regional sedimentation.

All the three rivers types transfer huge amounts of sediment. For the foothill and mountain fed rivers, a significant portion of this sediment is derived from natural and geological processes including landslides and other mass movements coupled with erosion of bed and banks. Rainfall events, particularly cloudbursts, accentuate these processes thereby increasing regional sedimentation. Coarse sediment deposition is particularly intense at the base of the hills where river gradients decline dramatically as they enter the main plains. In this zone, rivers shift

[4] The July and August 1954 floods in the Himalayan rivers that caused widespread flooding in Nepal and Bihar were a result of active breaks in the monsoon.

their channels frequently. Climate changes will clearly have an impact on sediment process, but the extent of the impact is not easy to quantify. The challenge is particularly complex because sediment base-loads, which are mobilised during intense flooding events, have never been possible to measure accurately. This lack of precise information is significant as water and sediment fluxes determine the design, operation and functioning of structural control measures such as embankments.

The following natural contexts are worth reiterating, as they influence responses and policies for flood "management". First due to steep orographic effects of the Himalaya and the low gradients of streams in the plains, inundation and sedimentation are natural. Secondly, immediately after debouching on to the plains from the hills, the rivers move laterally with a high potential of bank erosion. Third, a significant amount of the total rain falls within the plains. This contributes to flooding but is not entering the region through river flows from upstream locations. As a result, inundation from this source can only be addressed by measures to increase drainage, not by measures to confine rivers.

Climate changes will clearly have an impact on sediment process, but the extent of the impact is not easy to quantify.

The Evolution of Conventional Management Approaches

The structural approach is a narrowly conceived solution and ignores many important side effects.

The conventional approach to flood mitigation is rationalist in orientation and involves a two stage policy response. The first step involves collecting data about a flood hazard. In the case of flood mitigation, this step consists of collecting and analysing data on rainfall, river flow, river stages, sediment loads, and the economic and social systems likely to be affected by a flood. The second stage involves using the data to explain the nature of the flood hazard and then proposing and implementing mitigation measures. In the Ganga Basin, most responses to floods have focused on structural measures, including embankments, levees or dykes and reservoirs.

The building of embankments on the plains of the Ganga Basin to control floods began in the later years of the British Raj and proceeded more vigorously after India's independence. The 1954 Flood Control Policy enunciated by the Government of India and the first flood control plan in what was then East Pakistan espoused the structural path to flood control. Following this policy guidance, the government of India has constructed a total of 33,630 km of embankments,[5] about 3,454 km of embankments in Bihar, 2,681 km in Uttar Pradesh and 10,350 km in West Bengal. Bangladesh has built about 8,300 km of embankments since 1959. In Nepal, only a few hundred kilometers of embankments have been constructed.

The structural approach is a narrowly conceived solution and ignores many important side effects. Embankment construction has caused water logging of a large section of the plains. This in turn, has had high environmental and social costs that outweigh the perceived benefits of irrigation and flood control development (Gyawali, 1998; Dixit, 2003). The embankments have forced rivers to deposit their sediment within the embanked portion, raising the bed level of the river higher than the surrounding land. Floodwater seeps though the earthen embankment, while tributary rivers cannot drain into the rivers.

Together with bridges and raised highways, roads and railway lines, embankments have caused drainage congestion in the flood plains of the Ganga, thereby making people living there more vulnerable. According to Hofer and Messerli (2006) lateral river embankments and disappearance of natural water storage areas in the lowlands seem to have a significant impact on the flooding processes. Another factor that has exacerbated flooding disasters is population growth. With ever greater numbers of people competing for limited space, the poor (the vast majority) are forced to live in land most susceptible to flooding and congestion; i.e. within the flood plains themselves.

[5] Details are available at (http/wrmin.nic.in/publication/ar2000/arooch/5.html).

Using Flood to Advantage: Emerging global flood management trends

The Dutch have begun to acknowledge that it will be impossible to provide structural protection for the entire country.

As the shortcomings of relying primarily on structural flood control measures—so-called "hard control" measures—become increasingly apparent, various other approaches to flood mitigation are emerging. These include "soft resiliency" measures, such as the development of flood-adapted infrastructure within floodplains, ecosystem restoration, insurance for risk spreading and a variety of behavioral and institutional measures. Such measures compliment structural control techniques. Together they could enable crafting of multi-layer disaster risk reduction strategies that enable people to live with floods and other risks rather than attempting to fully control such risks.

The Netherlands provides an example of how such systems can evolve. The Netherlands is prone to flooding because significant portion of its land lies below sea-level and it also receives floodwaters from upstream sources along the Rhine. For years, the country has relied on an extensive network of levies and dykes to hold back the sea and river flows. Recently, faced with the threat of rising sea levels, more intense storms, and increased river flows, the Dutch have begun to acknowledge that it will be impossible to provide structural protection for the entire country and are instead proposing to construct levies in targeted areas in order to protect key assets and allow flooding to occur elsewhere. Other suggestions include the idea of floating cities or hydrometropols (Kabat *et al.*, 2005). Indeed such measures have conceptual and cost implications for Ganga Basin, particularly in relation to disaster losses and recovery.

The costs associated with disaster recovery can be exorbitant, and in developing country, contribute to an endemic state of poverty. Yet experiences elsewhere indicate that flood mitigation needs a broader approach than simply implementing structural measures. The economic devastation witnessed after the 1993 Mississippi River flooding point to the necessity of implementing disaster risk reduction measures which do not only rely on structural protection. After significant failure of flood protection structures along the Mississippi, the Federal Emergency Management Agency (FEMA) began working with affected communities to buy structures situated in the floodplain and allow strategic flooding. Those essential structures that could not be relocated are being voluntarily retrofitted and raised above the 100 yr flood level (FEMA, 1996).

Cost alone is, however, not the only issue. The cases of Hurricane Katrina, the Pakistani earthquake (2005) and the 2007 Asian floods highlight how race, class, gender and poverty interact to create a state of vulnerability to natural hazards. For many of the world's poorest, mitigating disaster risk has little to do with structural protection. For them, soft resilience measures, including access to credit and insurance to better prepare for and recover from disasters, transportation to be able to leave an area before disasters strike and during inundation, early warning and communication networks, and ecosystem restoration are more appropriate.

Specific Opportunities for Reducing Risks in the Ganga Basin

Financial opportunities to reduce risk include access to credit, the formation of self-help groups that can disburse loans and micro-credit, crop insurance and access to local markets.

Opportunities for risk reduction are emerging from field research to document the factors that increase people's vulnerability to flooding in the Ganga Basin (see previous chapters). Drawing upon a series of Shared Learning Dialogues with affected communities, non government organisations and some government officials, researchers have come up with a number of soft and hard resiliency suggestions for how vulnerability to natural hazards can be reduced. These take into account the unique interplay among physical, social, economic and political relationships.

The ability to reduce vulnerability to disasters is strongly related to the robustness of the following systems (Moench and Dixit, 2004):

1. **Communications** (including the presence of diversified media and accessibility of information about weather in general and hazards in particular);
2. **Transportation** (including during extreme events);
3. **Finance** (including access to banking, credit and insurance products for risk spreading before, during and following extreme events);
4. **Economic diversification** (access to a range of economic and livelihood options);
5. **Education** (the basic language and other skills necessary to understand risks, shift livelihood strategies as necessary, etc.);
6. **Organization and representation** (the right to organize and to have access to and voice concerns through diverse public, private and civil society organisations); and
7. **Knowledge generation, planning and learning** (the social and scientific basis to learn from experience, proactively identify hazards, analyze risk and develop response strategies that are tailored to local conditions).

Migration, on a seasonal or longer term basis, is an important risk reduction strategy for many households in the Ganga Basin. Although it alters community relationships and local resource management, migration can create greater financial resilience through remittances and reduced reliance on land-based livelihoods. Financial opportunities to reduce risk include access to credit, the formation of self-help groups that can disburse loans and micro-credit, crop insurance and access to local markets. These mechanisms provide individuals with a safety net should crops or possessions be damaged by natural hazards such as floods and provide incentives for behavioural change. For instance, micro-credit and loans allow farmers in Bihar and Uttar Pradesh to increase crop varieties and include drought or flood resistant species. Such measures also enable access seeds and equipment more rapidly in the aftermath of a flood event.

Non-financial options for improving resiliency include the expansion of

communication networks. The establishment of FM radio stations and penetration of cell phone networks increase the likelihood communities will be aware of key issues, including climate and weather, and functioning of early warning systems. The result is that individuals get more time to move assets, such as livestock, to safer places prior to a flood event.

Structural measures can be an important component of soft resiliency approaches but thinking about their design and purpose has to change. Their design should not seek to curb risk completely but instead to help the vulnerable live with risk and protect key assets. In other words the goal is flood adaptation, not flood control. In the past, poorly-designed flood and transportation structures simply aggravated flood damage: haphazardly placed embankments, for example, caused fields which would drain naturally in hours or day to be water logged for weeks. Some of the "new" (local populations have used some of these measures for generations) flood-adapted structural measures that are beginning to be employed in the Ganga Basin include:

Structural measures can be an important component of soft resiliency approaches but thinking about their design and purpose has to change.

- Raising the plinth height of houses and hand pumps.
- Building houses with flat roofs so that people have a safe place to go during floods and to store critical assets like livestock and seeds.
- Providing tarps and other materials to families so they can construct temporary shelters on their roofs.
- Constructing embankments only in locations where they are required to protect particularly high value areas (such as towns, cities, airports, etc…). Furthermore since it is not pragmatic to maintain many kilometers of embankments, stretches of embankments short enough for a community to maintain effectively on its own should be built.
- Constructing roads with adequate drainage or permeable bases so that they channel away rather than trap floodwaters and thereby help minimise damage to transportation infrastructure, allow for quicker post-disaster recovery, and reduce disruptions in access to local markets.
- Constructing new or improving existing schools or places of worship which are resilient to multiple hazards for use as community shelters.

These are only a few examples of the flood-adapted "soft resiliency" structural measures which, in combination with other soft resiliency measures could substantially reduce vulnerability to flood risks in the Ganga Basin.

Approaches to flood mitigation that combine flood-adapted structural elements with the other (transport, financial, communication, etc.) systems that contribute to build social resiliency could be an effective alternative to historical approaches. Limiting the use of conventional technology (primarily embankments) to the protection of small critical areas, applying measures which reduce flood impacts (improving drainage, raising the plinths of houses, etc.) and improving core systems that contribute to social resilience would represent a fundamental paradigm shift. Even when cities are protected by ring bunds providing proper drainage remains important because the within rainfall must be properly drained.

Summary

We focus on ensuring the uninterrupted drainage of flood waters, the minimisation of flood-related risks and the provision of livelihood diversification options.

The four monsoon months when flood hazards occur in Ganga Basin bring large-scale inundation, which, coupled with social factors, causes much hardship to the people in the plains; those in the hills also suffer from their fair share of problems, including landslides and mud and debris flows. In the plains investments in implementing flood control measures such as embankments, flow modification structures, and bank stabilisation has been significant but these structural approaches have not ameliorated the impacts of flood disasters. In fact, they have exacerbated them, a fact which makes it evident that the intent to control flooding completely is not possible. Nor is it desirable. Instead, the focus should be on flood damage mitigation. Such an approach focuses on ensuring the uninterrupted drainage of flood waters, the minimisation of flood-related risks and the provision of livelihood diversification options.

Contrary to expectation, embankments have not provided security from flooding. In regions of high intermittent high rainfall and high water tables, embankments have negative impacts, which their conception, design and construction ignore. Because a river's sediment load is deposited within embankments, the levels of riverbeds rise until they are higher than the sluice gates placed to allow tributary rivers to drain into the main river. Thus, they prevent tributaries from emptying into main rivers. Also because riverbed levels eventually exceed that of the surrounding land, water begins to seep from the embankment and spread across the flood plain. As a result, floodwaters that would have naturally drained in a few hours or days remain for weeks and the land becomes waterlogged. In addition, embankments give a false sense of security to those who live in such "protected" areas as they can be easily over-topped or breached by a flood whose levels exceed the embankment's design specifications. Another common problems is that the sluice gates placed in embankments are generally poorly maintained and do not function as they are designed to.

The realities presented above make it clear that there needs to be a paradigm shift away from controlling floods to providing unhindered drainage and learning to live with risk. This idea is not a totally new one in South Asia. In the colonial era, British engineers argued for providing unhindered drainage, cushioning floodwaters in ponds and depressions, and promoting inland fisheries. The report of the 1928 Flood Committee, constituted to deliberate on the Mahanadi floods of 1927 concluded that in the case of Orissa, the annual deltaic inundation was a part of the "working of nature" and noted that the problem was not how to prevent flood but how to pass then as quickly as possible to sea.[6]

[6] The reference to Orissa Flood is based on D'Souza (1999).

Focusing on unhindered drainage would set the stage for creating conditions that minimise inundation during the monsoon season, but improving drainage is only part of the story. Adopting soft resilience strategies to spread risk and reduce vulnerability is equally important in helping people learn to live with flooding and other weather-related hazards. The key to success is to also ensure that opportunities for different ways of working exist

Bibliography

Agence France Presse, 2007: *Cost of South Asia floods Nears One Billion Dollars*, accessed via LexisNexis August 14, 2007.

British Broadcasting Corporation, 2007: *Surviving on Snails and Rats in Bihar*, http://news.bbc.co.uk/go/pr/fr/-/2/hi/south_asia/6937267.stm, accessed August 13, 2007.

Dhar O.N. and Nandargi S. S., 1998: Floods In Indian Rivers and their meteorological aspects in *Flood Studies in India,* Kale V. S. (ed.), Geological Society of India, Bangalore.

D'souza R., 1999: The Problem in Floods a Symposium on Flood Control and Management, *Seminar* 478 June New Delhi

Dixit A., 2003: Flood and Vulnerability: Need to Rethink Management, *Natural Hazard,* Vol 28, No. 1.

FEMA, 1996: *Report on Costs and Benefits of Natural Hazard Mitigation*, Government Printing Office: Washington DC, pp. 57.

Government of Bangladesh, Disaster Management Information Centre, Disaster Management Bureau (DMB), Ministry of Food and Disaster Management, 2007: *Flood Situation*, Situation Report for period Aug. 25-26.

Government of India, Ministry of Home Affairs, 2007: *Southwest Monsoon-2007: Daily Flood Situation Report*, Sitrep No-89/2007, August 28.

Gupta A., 1988: Large floods as geomorphic events in humid tropics in: *Flood Geomorphology,* Baker V. R., R. C. Khochel, and P. C. Patton (ed), John Wiley and Sons: New York. pp 151-177

Gyawali, D., 1998: Patna, Delhi and Environmental Activism: Institutional Forces Behind Water Conflict in Bihar, *Water Nepal* Vol.6, No. 1, 67-115 Nepal Water Conservation Foundation, Kathmandu

Hayden, B.P., 1988: Flood Climates in: *Flood Geomorphology,* Baker V. R., R. C. Khochel, and P. C. Patton (ed), John Wiley and Sons: New York.

Hofer, T. and Messerli, B., 2006: *Flood in Bangladesh History, Dynamics and Rethinking the Role of the Himalayas* United Nations University.

Intergovernmental Panel on Climate Change, Working Group II, 2007: *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability, Summary for Policymakers*.

Kabat, P., *et al.,* 2005: Climate Proofing the Netherlands, *Nature* 438: 283-284.

Kale V. S., 2003: Geomorphic Effects of Monsoon Floods on Indian Rivers, *Natural Hazard,* Vol. 28, No. 1.

Kale V. S., 1998: *Monsoon Floods in India: A Hydro-Geomorphic Perspective* in Flood Studies in India*,* Kale V. S. (ed.), Geological Society of India, Bangalore.

Moench, M., and A. Dixit (Eds.), 2004: *Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for Responding to Floods and Droughts in South Asia*, Institute for Social and Environmental Transition, Boulder and Kathmandu: 244 pp.

Oxfam International, 2007: *Sink or Swim*: *Why Disaster Risk Reduction is central to surviving floods in South Asia*, Oxfam Briefing Note August 12, 2007.

Rackecha P.R and Pisharoty P. R., 1996: Heavy Rainfall during Monsoon Season: Point and Spatial Distribution, *Current Scientist*, 71: 179-186

Ramaswamy C., 1987: *Meteorological Aspects of Sever Floods in India* 1923-1979 MMH No 10, Indian Meteorological Department New Delhi

Red Cross and Red Crescent Societies Nepal, 2007: *Nepal: Floods and Landslides*, Appeal no. MDRNP001, Glide n°. FF-2007-00017-NPL, August 29.

Reuters, 2007: *Smell of floating corpses adds to S. Asia flood woes*, accessed via LexisNexis August 22, 2007.

The Guardian, 2007: *International: Infections spread as toll from Asian monsoon hits 2,000: Lack of drinking water is most pressing problem: Saudi Arabia boosts international aid effort*, accessed via LexisNexis August 13, 2007.

Waliser, D.E., *et al.*, 2003: Potential Predictability of the Madden-Julian Oscillation, *Bulletin of the American Meteorological Society*, DOI: 10.1175/BAMS-84-1-33.