Adaptation and Livelihood Resilience

Implementation Pilots and Research in Region Vulnerable to extreme Climatic Variability and Change

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Published by
Institute for Social and Environemtnal Transition-Nepal (ISET-N)

ISBN: .....

PREFACE

This report summarises our study in northern Ganga plains and coastal Tamil Nadu and Gujarat. The objective of the study was to pilot tasks to enable local communities better deal with impacts of climate variability and anthropogenic climate change such as floods and droughts. We pursued a "learning-by-doing" approach to respond to the interwoven elements of the complexity vis-à-vis climate change.

Our approach was based on two basic premises. First, degradation caused by anthropogenic interference is a result of multiple human actions shaped by state policy, economy, market, and livelihood opportunities. Our study shows that successful adaptation is akin to building resilience and requires shifting of many existing practices. Such shifts can be fostered by "institutional tinkering", which in turn depend upon many players with power differentials changing their behaviour. Second, the specific problems of different regions are important but poorly understood. We need better grasp of the underlying processes, limitations and opportunities.

Any approach to support adaptation needs to be flexible to learn from the experience and improve the strategy as new constraints emerge. We started with this basic assumption and moved ahead seeking local participation to achieve our objectives. Our focus was on generating new understanding through shared learning. The insights helped us fine-tune our strategies and activities.

This report builds on our many earlier reports. It also reflects the collective journey of creative enquiry being undertaken by researchers from Nepal, USA, India, Bangladesh and Pakistan in responding to the challenges as economic and technological globalisation bring about fundamental changes.

We believe that the report takes our understanding of climate change adaptation a step forward contributing to both theory and practices.

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ACKNOWLEDGEMENTS

We take this opportunity to thank all those who helped in completing this study. Over the years we have benefited from the constructive suggestions of Dr Stephen McGurk, Elizabeth Fajber, Dr Simon Carter, Dr Marco Rondon and Dr Sara Ahmad of International Development Research Centre (IDRC). We thank the community members in Nepal Tarai (Rautahat and Nawalparasi districts), Eastern Uttar Pradesh, Coastal Tamil Nadu and Gujarat for their cooperation. Eva Saroch provided initial input in preparation of this report. Madhav P. Thakur and Mela Aryal of ISET-N commented on the draft at final stages. We are grateful to Dipak Gyawali for his intellectual support. Suresh Shrestha of Format Graphic designed the layout of this report with support from Narayan Shree Adhikary, Geeta Bhomi, Sunita Munankarmi and Ganga Shrestha of ISET-N.

The study period lasted from March 2006 to March 2009. Subsequently, IDRC granted a no cost extension to the project till September 2009. This and the period after was used in writing the report, orgasining the Technical Conference on Adaptation in August 2009, synthesising and printing of the conference proceeding. We have also published a policy brief containing twenty two case studies on adaptation. Eleven of the case studies are directly based on lessons from this study.

Some of the research team members have now new institutional affiliation. Dr Sara Ahmad has joined IDRC as a programme officer. Shashikant Chopde, Praveen Singh and Anil Pokharel have also moved on. This report has benefited from their input at different stages. We would also like to thank all our research colleagues for their support and cooperation.

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BACKGROUND

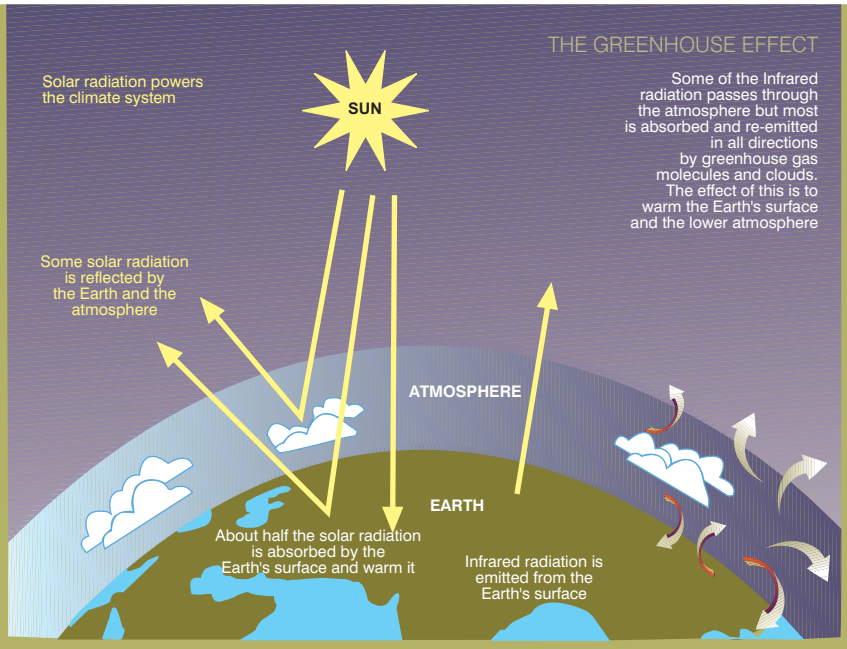
Adapting to anthropogenic climate change impacts is an imposes aditional burden to developing countries and their populations.

A television newscast aired on the evening of 8 July 2009, portended disaster for South Asia's largest nation: if the arrival of the monsoon in North India was delayed by just one week, the reporter claimed, drought-like conditions would prevail and farmers would commit whole-scale suicide. The very next day the BBC web site reported that one of the worst water shortages in history had forced authorities in Mumbai to reduce water supply by almost a third and that cuts had hit the population hard. From householders to hospitals to hotels, it observed, all residents were struggling because the lakes which supply water to Mumbai have dried up. Ironically, only days earlier, another television broadcast had flashed images of the streets of Mumbai being inundated by flood water and lashed with monsoon downpours.

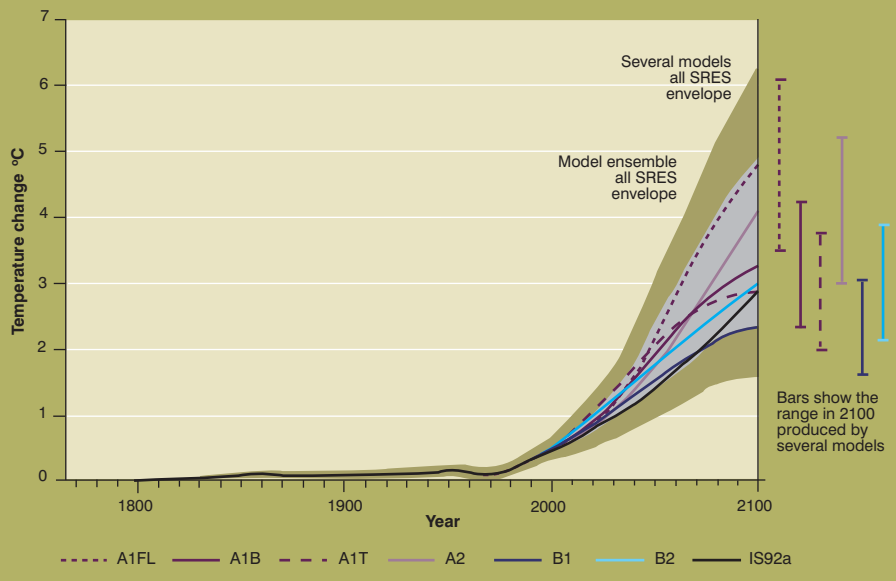
A year ago in August 2008 the embankment of the Koshi River in Nepal had breached affecting million in Nepal Tarai and Bihar. The breach occurred when the flow of the river was lower than the average flow that month. The disaster resulted from institutional failure (Dixit, 2009) and can be used as a signature event whose impacts are consistent with those projected to occur as a consequence of climate change. Though the Koshi embankment breach was not caused by climate change, it does show what can happen if climate change increases the frequency and intensity of climate-related flood hazards and is, in consequence, a valuable source of learning. At the same time, the year 2008 and 2009 saw Nepal's mid hills and Tarai face extended drought conditions and forest fire on a massive scale (NCVST, 2009).

While the denizens of South Asia bravely faced the adverse impacts of an erratic monsoon, the leaders of the G8 leading industrial countries assembled for a summit in the Italian city of L'Aquila. After – days of talks, they agreed to try to limit global temperature rise to just 2°C above pre-industrial levels by the year 2050. While they also set tough new targets for the cuts in carbon emissions deemed necessary to achieve that goal, they gave no indication of how either the targets or the cost would be met. Subsequent global meeting organised to face the threat of global climate change proved even more elusive as the governments failed to reach a consensus on substantial reduction of green house gases in the fifteenth meeting of the Conference of Parties (COP) held in Copenhagen in December 2009.

BOX 1.1
The global science



Adapted from IPCC (2007)



Estimated historical and range of predicted future global average temperature rises for various emission scenarios (A1FI - B1) and various global climate models (Cubasch et al, 2001, p.554). Note that up to the mid-21st century, 'science' uncertainty (i.e. the range of temperature change produced by the different climate models) heavily dominates over emissions uncertainty, and they are roughly equal by the end of the century. However, at a regional level, science uncertainty dominates even by the end of the century. Adapted from Willows, and Connell (Eds.) (2003).

Adapted from Willows and Connel (eds. 2003)

In its Fourth Assessment Report (AR4) of 2007, the Intergovernmental Panel on Climate Change (IPCC) reported that between 1990 and 2005 the global average temperature had increased between 0.15°C and 0.3°C. Various future scenarios of global emission levels project that global temperatures will rise between 1.1°C and 6.4°C by 2100 if action is not taken.

The AR4 predicts a warmer climate for South Asia too. The impact of the higher temperatures is likely to be precipitation extremes of increasing frequency and intensity and increasingly erratic annual rainfall. It is expected that climate change will have a profound impact on the following areas:

- **Water resources:** Water availability is projected to decrease in the mid-latitudes and the dry tropics and the extent of drought-affected areas is likely to increase. Paradoxically, the risk of floods will also increase as heavy precipitation events grow more frequent;
- **Ecosystems:** An increase in the average global temperature will trigger major changes, predominantly negative ones, in ecosystem structures and functions (the provision of goods and services) as well as the in ecological interactions among and geographic ranges of species and biodiversity;
- **Crop production** at lower latitudes, especially in dry and tropical regions, is projected to decrease even with small increases in local temperatures.

Poor countries and communities dependent on climate-sensitive livelihoods like agriculture, forestry and local water supplies are likely to suffer the most because they have fewer options and lack the institutional capacity to adapt.

According to a CNN report dated 19th December U.N. Chief Ban Ki-moon said a "deal has been reached" that could be the framework for a binding global climate change treaty. Said Ban "Finally we sealed the deal and it is a real deal. Bringing world leaders to the table paid off, adding that "The Copenhagen Accord may not be everything that everyone hoped for but this decision of the conference of parties is a beginning, an essential beginning." The non-binding deal called for all countries to limit global temperature rise to below two degrees Celsius and was mentioned to be a step toward creating a legally binding treaty." The deal also pledged up to $30 billion for adaptations and mitigation.[1]

These snippets from these headline news and past events demonstrate the fast paced global context as the world attempts to come to terms with and tackle the challenge of global climate change. As the global temperature goes up so does climate patterns become more erratic which has and will directly impinge in the life and livelihood of millions of people in South Asia and many other parts of the world. The problem will only grow worse particularly because the precipitation pattern become more uncertain with fewer days of rain and more high-intensity rainfall events becoming more frequent. The later pattern of rainfall has resulted in an increase in the magnitude and frequency of water-induced hazards like landslides, debris flow, and floods. The impacts make any hot spots regions of South Asia more vulnerable to climate change impacts.[2]

While it is established beyond reasonable doubt that human induced climate change is a reality and further changes inevitable, understanding of the changes and the scale of impact in the hot spot regions and the people who live there remains a challenge. One factor is poor understanding of the interaction between global climate and the regional climate systems such as the South Asian Monsoon (SAM). This complexly has many potential interactions and feedbacks. Over the years, climate models such Global Circulation Models (GCMs) and Regional Circulation Models (RCMs) have attempted to incorporate this complexity and develop a more robust future climate change scenario.

A recent analysis of climate change scenario (NCVST, 2009) in Nepal Himalaya has suggested that uncertainty will increase particularly in precipitation pattern. This study is relevant to mention because climate characteristic of Nepali landscape, as one of the most complex regions in the world, helps appreciate its emerging dynamics likely to be affected by higher concentration of green house gases but cannot be totally explained. The analysis used temperature and rainfall data collected in Nepal from 1970 to 1999 and used 15 GCMs, four RCMs and two précis models to develop the scenario. The analysis presented the following key insights:

- GCMs projections indicate an increase in temperature over Nepal of 0.5 to 2.0 °C, with a multi-model mean of 1.4 °C, by the 2030s, rising to 3.0 to 6.3 °C, with a multi-model

[1] The deal came about after U.S. President Barak Obama worked behind the scene with leaders from India, China, Brazil and South Africa. Before leaving the conference Mr. Obama said. "For the first time in history, all major economies have come together to accept their responsibility to take action to confront the threat of climate change, ".He added that it is a first step, and that for many countries "this is going to be the first time in which even voluntary they offered up mitigation targets." Critics of the U.N. Climate Change Conference however said that without specific commitments from the leaders to actually cut carbon emissions it would be difficult to reach any target. Environmental group Greenpeace released a statement criticizing the deal as follows, Greenpeace said, "Don't believe the hype, there is nothing fair, ambitious or legally binding about this deal, "The job of world leaders is not done. Today they shamefully failed to save us all from the effects of catastrophic climate change."

[2] See Chapter 3 for a discussion on hot spots

mean of 4.7 °C, by the 2090s. There is very little differentiation in projected multi-model mean temperature changes in different regions (East, Central and West) of Nepal.

- GCM outputs suggest that extremely hot days (the hottest 5% of days in the period 1970-1999) are projected to increase by *up to* 55% by the 2060s and 70% by the 2090s
- GCM outputs suggest that extremely hot nights (the hottest 5% of nights in the period 1970-1999) are projected to increase by *up to* 77% by the 2060s and 93% by the 2090s
- GCMs project a wide range of precipitation changes, especially in the monsoon: -14 to +40% by the 2030s increasing -52 to 135% by the 2090s.

The future scenario of temperature increase projected by various models was consistent with its observed rise in the Himalaya, but the models suggested significant variation in precipitation. For example, in 2090, the scenario of monsoon rainfall projected by the model varied from 52 percent reduction to 135 percent increase. This result is also a reflection of the difficulty posed by difficulty of limited data availability, poorly understood monsoon dynamics and complex topography characteristic of the Himalayan region. They present profound challenges for projecting climate change using GCM outputs which must be interpreted and used cautiously (NCVST, 2009). With improved understanding of the interaction among clouds, oceans, land surfaces, mountains, aerosols, chemistry, and the carbon cycle,[3] better datasets and higher computational capacity robust scenario can be generated. Regardless, models cannot make precise projection of future climate given the complexity of the real world, and inadequate datasets in many regions. As a result, uncertainty will continue to remain hallmark of future climate world. These limitations however should not be construed as barriers to assessing vulnerability to climate change impacts, selecting options for adaptation and in devising appropriate social and political opportunities for implementing them.

In South Asia, the fluctuations in precipitation associated with global climate change have, in fact, led to a paradoxical situation: there are more droughts and more floods, often simultaneously. To complicate matters, the regular and recurring floods and droughts which plague much of Nepal, Northern India and Bangladesh occur frequently in those areas that are already vulnerable to extreme events and climate change. Disasters caused by institutional failures, such as the breach of the embankment of the Koshi River on 18 August 2008 (Dixit, 2009), only serve to exacerbate the growing losses in life and livelihood that the region has experienced. In addition, the climate stress adds a new layer of stress on a social and political context with development and governance deficit.

Deficit in both development and governance results from historical, social and political factors. The outcome is perpetuating of poverty, social and gender inequality, disenfranchisement, corruption, ill-conceived subsidies, and unequal access to social, political, economic, and natural resources and capital. Thus, almost all countries of South Asia fall in the terrain where normal challenge of development is entangled with the additional stress imposed by climate change. What factors will help us disentangle the blur between development and adaptation? Short-term

[3] Adapted from Pope Vicky (200&) Models 'key to climate forecasts, UK Met Office's Hadley Centre in BBC web site.

climate variability and long-term climate change are one more set of constraints within which the already vulnerable people of the region cope with everyday living. As at global level negotiators, decision-makers and politicians debate what adaptation is, who is responsible for promoting it and how to finance it, people on the ground have already begun to respond to complex change processes, including those related to weather and climate.[4]

This report summarises the finding of the study "Adaptation and Livelihood Resilience; Implementation Pilots and Research in Region Vulnerable to Extreme Climatic Variability and Change"(carried out an integrated programme of research, pilot implementation, local capacity-building and up-scaling design to develop, test and document practical interventions that incorporate disaster risk reduction, rehabilitation and mitigation. The study also aimed to establish their links with the identification and development of resilient livelihoods and adaptive capacity. There were two goals of the study. First, to implement the results of the research of the Adaptive Strategies Project (Moench and Dixit, eds. 2004) at the field level; and, second, to increase understanding and awareness of adaptation processes and the implications of such processes in development, governance, risk reduction and disaster relief initiatives, at both national and international levels of policy and implementation. The study received support from a consortium of donors and International Development Research Center (IDRC).

The findings of the study demonstrate that, no matter what the climate change scenario in the decades ahead will be (and we cannot say for certainty what that will be), it is the ability of local populations to adapt that determines their vulnerability and the key to reducing the vulnerability is increasing their livelihood resilience. The study focused on those areas of South Asia that are particularly vulnerable to the impacts of climatic variability and change, including coastal zones and regions affected by floods and droughts. Working in close collaboration with a broad network of local partners who have an established field presence in Nepal and India, it aimed to meet the following goals:

1. Implement, on a pilot basis, the insights of the Adaptive Strategies Project, including programs for watershed development, drought-proofing, flood mitigation and coastal post-tsunami reconstruction;
2. Launch a carefully targeted program of research to (a). manage knowledge on local coping strategies, changing dimensions of vulnerability and other key issues (b). address key issues (such as the roles of migration, remittances, formal and informal insurance, communication systems for early warning and the governance of risk reduction) that were identified as central to adaptation but not adequately documented in the earlier research process, (c) identify specific avenues for incorporating research results in the activities of programs currently being run by the governments of India and Nepal, by donors, including multilateral and bilateral organizations, and by foundations; and finally (d) extend the evaluation of the factors affecting adaptation and livelihood resilience to new contexts.
3. Support and build capacity within concerned non-government and government organizations (especially at the local level) in ways that help them

[4] This section is based on Laura *et al* (2009)

shape their programs and activities to build adaptive capacity and livelihood resilience;

4. Coordinate as closely as possible with other research and implementation organizations working on adaptation, climate change and disaster response-related issues;
5. Link effectively with the private sector and improve understanding of the roles private companies and the market can play in adaptation; and
6. Disseminate its results in forums that address local implementation issues in specific regions, influence policy, and contribute to wider global debates over practical avenues for responding to disasters and the long-term management of climatic variability and change.

Purpose and Approach

A series of extreme events, primarily floods and droughts, have hit South Asia over the last three years. The year 2009 has been characterised by paradox as the simultaneous occurrence of droughts and floods that strained the region's already over-stretched capacity to respond. Its limitations were particularly plain to see in the shocking aftermath of the 2004 tsunami and the 2008 Koshi flood. Neither disasters were related to a climatic hazard, yet both demonstrate how severe the impact of climate change will likely be. The devastation caused by the 2007- flood in Gujarat and Maharashtra and by Hurricane Katrina in New Orleans is just a taste of what is to come. Already 2009 saw monsoon floods devastating the plains of Nepal, North India and much of Bangladesh:[5] over 5,000 Nepali families were displaced and thousands of hectares of land were washed away due to flooding and drainage congestion.[6] In Bihar, more than 1000 died.[7] And the drainage problems associated with the construction of embankments merely complicated problems.

While the Ganga basin was dealing with floods, western India was battling drought. In Maharashtra, the situation was dire due to drought. The BBC reported that "farmers have been committing suicide for the past three years in despair at crop failure, drought and growing indebtedness."[8] A local official had this to say: "If it does not rain – and rain well – in the next eight to 10 days, 35-40% of all the crops will be destroyed. If there is no rain for 15 days, the situation will get very serious". Rain did come eventually–too much rain. In fact, it rained so much that thousands in Gujarat ended up displaced by extensive flooding. In many years, however, the monsoon rains "fail". In 2003, for example, Rajasthan received only 220.4 mm rainfall up to 30th September, against the normal monsoon of 518.6 mm. The overall rainfall deficit in the state was –57.5% and the rainfall deviation ranged from –90.1% in Bikaner District to +32.0% in Jhalawar District.[9] The year 2003 was the fifth consecutive year of drought while the situation was somewhat better in 2004 as it did not change in any fundamental way. As one newspaper report stated, "faced with the looming threat of drought, Rajasthan is planning to ask the central government for Rs.90 billion (Rs. 9,000 Crores) in aid."[10] Recently in Punjab, the breadbasket of India, precipitation

[5] The New York Times, 7/27/04

[6] Nepal News (www.nepalnews.com) 7/27/04

[7] http://news.bbc.co.uk/2/hi/south_asia/3928463.stm 7/27/04

[8] http://news.bbc.co.uk/2/hi/south_asia/3916559.stm 7/27/04

[9] RAJASTHAN DROUGHT SITREP January 24, 2003, www.un.org.in/UNDMT/sitrep/drought/Rajasthan—Drought— SitRep240103.doc

[10] http://www.thepeninsulaqatar.com/Display_news.asp?section=World_News&subsection=India&month=July2004&file=World_News20040724382.xml

has been far below normal,[11] as was the case in many parts of the Ganga Basin in 2005. Climatic anomalies like these lead to disasters.

As records demonstrate, disasters are not a new phenomenon in South Asia: right throughout history, for example, cyclones have had a major impact on coastal regions. The 1999 Orissa super cyclone destroyed over 1.8 million houses and killed more than 10,000 people.[12]

While such difficult-to-predict and extreme climatic variations are an inherent part of the life of South Asians, there is evidence that climate change increases their variability, frequency and intensity, thus increasing their impact on lives and livelihoods. The Intergovernmental Panel on Climate Change (IPCC) has concluded that at least part of the recent increase in economic losses attributable to weather extremes stems from changes in climatic conditions.[13] It is however difficult to separate the role of a changing climate from the roles of the many other factors which influence losses attributable to the vagaries of weather events. Difficult though it is to forecast global warming, the fourth official assessment report of IPCC (2007) states that global warming is an undeniable reality, one manifested in records of increases in global average air and ocean temperatures, widespread melting of snow and ice, and the rising global average sea level. It also asserts with "very high confidence that the globally averaged net effect of human activities since 1750 has been one of the major contributors of global warming".[14]

While the IPCC (2007) does aver that climate change will increase the intensity and frequency of weather extremes over the next half-decade, it also states that in developing countries it is non-climatic factors, especially the increasing number of settlements in high-risk areas and the intensive use of land, which appear to contribute more to the increasing losses.

Regardless of the cause, however, the increase in disaster-related damage and loss poses a serious challenge to South Asian countries. It goes without saying that disasters take human and animal lives, destroy property and infrastructure, and impair social and economic systems, especially those of the poor and marginalized, who often suffer from disaster-associated disease outbreaks and are driven deeper into poverty. Disasters also destroy habitats and disrupt basic ecosystem processes, including nutrient cycling and species breeding. Such losses of ecological wealth can make human populations more vulnerable. In fact, recurrent disasters undermine the ability of communities, regions and nations to meet many basic development goals.

Requests for humanitarian assistance from external actors, including government and non-government donors are constant because many people lack resilience in the face of regular climatic variability. Their livelihoods are often poorly adapted to disasters and they simply cannot cope. Furthermore, both governments and the disaster-affected persons may

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[11] http://www.webindia123.com/news/showdetails.asp?id=43751&cat=India 7/23/04

[12] http://www.un.org.in/orissa.htm, http://news.bbc.co.uk/hi/english/static/in_depth/world/2000/dealing_with_disaster/orissa.stm

[13] IPCC's Third Assessment Report (2001) concluded with 66-90% confidence that during the 20th century the frequency of extreme precipitation events had increased in mid and high northern latitudes (see Schönwiese *et.al.* 2003) and with 67-95% confidence that the occurrence of extreme weather events, including floods, droughts, forest fires and tropical cyclones, had increased in temperate and tropical Asia. It also noted that there were some indications of increases in extra-tropical cyclone activity in the northern hemisphere during the latter half of the 20th century and that more pronounced severe dry events had occurred in the past decades over Sahel, eastern Asia and southern Africa.

[14] IPCC 4th Assessment Report (Synthesis),Available online at: http://www.ipcc.ch/publications_and_data/publications ipcc_fourth_assessment_report_synthesis_report.htm (July 22, 2009)

inadvertently increase vulnerability by pursuing non-adaptive or mal-adaptive policies and practices. If the annual cycle of disaster and relief is ever to be broken, it is essential to build both livelihood resilience and local adaptive capacity.

Moench and Dixit (2004) have identified specific points of entry for South Asian communities where carefully targeted development assistance could help to build livelihood resilience and the adaptive capacity of local population.[15] Catalytic assistance of various types as listed below, they argue, would mitigate the impact of "normal" flood and drought conditions on livelihoods and, in consequence, reduce recurring demands for disaster relief. They also consider an array of factors listed below which could reduce vulnerability in much more fundamental ways. Greater understanding their groundbreaking research can help us to develop practical recommendations for integrating development and disaster mitigation policy and practices. Besides outlining flood and drought response patterns at the household level, it identifies the following factors that determine vulnerability to and the social impacts of floods, droughts and climatic variability. Obviously, these factors differ from community to community and even from individual to individual.

1. The nature of livelihood systems within a region, in particular, the extent to which individuals and households are able to diversify and incorporate non-agricultural components (which are less likely to be disrupted by natural disasters) into their income-generating strategies;
2. The ability of people to migrate or commute in order to obtain access to agricultural or non-agricultural sources of income outside of drought- and flood-affected areas;
3. The ability of information, goods and services to flow into and out of affected areas, including dissemination of knowledge related to climate policies and practices;
4. The social capital and institutional checks and balances that households have access to, including education, community institutions such as self-help groups, formal institutions such as government departments and banks, non-government organizations, the media, and social networks;
5. Existing patterns of vulnerability created by gender, income and social position;
6. The nature of physical infrastructure, including roads, houses, and water supply, in particular,
   a. the degree to which such infrastructures are vulnerable to being disrupted by disaster; and
   b. the extent to which such infrastructures allow for the maintenance of livelihoods by serving as a point of refuge, helping to protect assets, and facilitating the movement of goods, services and people;
7. The ability of households to obtain secure sources of water for domestic uses (whether by exploiting local sources, distant water markets, or rural supply schemes); and
8. The degree natural resources, particularly ground and surface water systems, are disrupted. Specific indicators follow:
   a. long-term declines in water level signal increasing vulnerability to droughts; and
   b. profusion of structures such as roads, bridges, and embankments interferes with the existing patterns of natural

[15] The Adaptive Strategy Project drew insights from the Local Water Management Project supported by IDRC. For details see Moench *et.al.* (1999)

drainage increasing the likelihood of flooding.

The eight bullet points listed above suggest key lessons useful to broaden the scope of enquiry on adaptation research. This study has integrated these insights into its five basic themes, which, although required to be adjusted to reflect local conditions, nonetheless served as general points for further research.

Our Assumptions

We began the research with following assumptions and understanding:

1. *The roles of income diversification, migration, commuting and remittance income in livelihood resilience and adaptive capacity*: Migration continues to remain important in adaptation process. Our research aimed to document the roles which specific factors, including migration and income diversification, play in enabling some individuals and households to adapt more successfully to floods, droughts and other extreme climatic events than others with similar vulnerability profiles. In particular, study looked at how gender, social exclusion and poverty affect patterns of vulnerability. Another angle of exploration was the manner in which constraints on adaptation can lead to the creation of new patterns of vulnerability[16] as well as the ways in which adaptation can reduce vulnerability. Innovative ideas like setting up improved and affordable insurance systems which link disaster pooling with risk reduction and which are subsidized by the donor community (thus re-orienting assistance from post-disaster relief to pro-active measures) also is key. Our study broadly examined the role of remittance and the measures that can be taken to ensure that it is spent on development and adaptive initiatives rather than on largely unproductive purchases like housing and jewelry. Study looked at the role of information and communication technology as a necessary condition.

2. *The role of environmental management in building resilience:* Research on this theme focused on the way the management of environmental resources supports local-level adaptive capacity and resilience. It included investigations into the role of watershed management in maintaining soil moisture and water availability in drought-affected areas, the role of protected forests and riparian vegetation in controlling floods, and the role mangroves play in buffering the impact of extreme events like storms and tsunamis on coastal areas. The study also focused on the specific courses of action that communities had already undertook or could undertake to preserve environmental resources that contribute to resilience.

3. *Changing dimensions of vulnerability*: A third focus of research was understanding those factors that will create vulnerability and how they are changing for specific groups, including women, children and the poor, whose vulnerability levels are generally high. Our research attempted to move beyond the already well-known dimensions of vulnerability to look at how

[16] Middle-income farmers, for example, may be more vulnerable than the poor to certain forms of disaster because they have less experience with systems such as regional labor markets that enable them to obtain access to income when their livelihood system is disrupted. Similarly, the need to diversify income may increase the vulnerability of specific groups (such as women) when access to high-quality, non-farm activities is limited.

vulnerability is changing with the context of economic development, migration and peri-urbanization. We also investigated how access to resources such as education, credit, communications, transport, and insurance as well as to natural resources differed from group to group. Another interest was how development itself (such as the emergence of large-scale groundwater irrigated agriculture) may change vulnerability in ways that run counter to generally accepted wisdom, that such practice will build resilience.

4. *The role of integrated multi-purpose communications systems in adaptation, resilience and risk reduction:* This aspect of field and policy research focused on understanding and then improving the multiple roles effective communication systems (packages of technologies, interfaces and social interpretive frameworks) play in establishing a foundation which enables individuals, households and communities to adapt and develop resilient livelihoods. Research improves understanding about the operation of existing communications systems and identifies points of entry where enhancements (using either existing or new technologies) can increase resilience and adaptive capacity, particularly amongst traditionally disadvantaged social groups (women, children, and the physically challenged among them) within the targeted communities. The study will accord particular attention to broadcasting early warnings through communications systems daily.

5. *Factors governing the effectiveness and strategic focus of pilot implementation activities*: Research on this theme included a major programme to monitor and evaluate the effectiveness of pilot implementation strategies, especially how decisions are made and how governance influences both the choice and effectiveness of activities. It focused on the development of disaster relief criteria that development organizations use to tailor the strategies they adopt to specific local conditions so that they best suit variables like the nature of vulnerability, natural resource conditions (such as the availability of groundwater and the manner of its use) and the presence or absence of transport, communication and other infrastructure.

The five research themes above helped underscore the fact that the ability of people to adapt to the impact of floods, droughts and climatic variability broadly varies depending on factors that cross local, regional and national boundaries. These conditions also determine how people cope. The five themes are not stand-alone components; they are the strands of an integrated research programme. Our research also attempted to make a distinction between adaptation and coping serving as guides, not strictures. These starting points provided the flexibility to branch out into previously unrecognized avenues and did not constrain research in any way. The research process thus allowed new insights to emerge.

Many earlier studies focus on singular outcome efforts and aimed for top down solutions. The four key characteristics which set this study apart from past efforts on research into adaptation are outlined below.

1. *Broad approach in scope.* Attention to adaptation is not new: successful development works and disaster risk reduction efforts, projects which have been around for ages, are, in many ways,

examples of adaptation. This project, however, approached adaptation in a markedly different fashion. First, its perspective is shaped by a concern with structural linkages among actual implementation, research, capacity building, learning and dissemination, not just on study. Another key difference is that it relied on a collaborative approach and contained structural mechanisms to actively encourage interaction with other groups involved in related work. Finally, the combination of its perspective and approach made this study reflexive. It allowed new insights that build off the existing local knowledge to be generated, rather than attempting to impose a grand design from above.

2. *Identified proactive points of entry.* Unlike most research on adaptation, this project was not reactive; instead, its combination of globally informed research with pilot implementation activities at the field level enabled it to engage in the pro-active identification of points where incremental changes in existing programs or carefully targeted development activities can help to build resilience and enhance adaptive capacity. Providing accessible, low-cost, but innovative and technically robust communication systems, for example, can serve as a core part of the foundation for resilient and adaptive livelihoods. Cell phones, in particular, enable people to develop social networks, access market information and engage in myriad other activities that build productive livelihoods. Encouraging activities that integrate early warning functions into robust and affordable multi-purpose communication systems in order to promote risk reduction, livelihood resilience and adaptive capacity is another pro-active step. Fostering proactive strategic intervention may even obviate the need for massive government assistance by roping in the private sector. Pinpointing entry points will enable development organizations and governments to respond to climatic variability and changes with precision and in advance; they will not have to address "everything under the sun."[17]

3. *Results designed to be up-scaled.* The issue of scale is directly related to the question of which strategic points of entry to select, with the symbiotic participation of local community-based organizations and the private sector. Once we identify key points of leverage for reducing future disaster risks, such as communication programs, credit, insurance and self-help groups, private organizations can be motivated to channel large amount of assistance into actions that will reduce future risks. What is needed is research designed to identify precisely those points of entry where targeted catalytic interventions are most likely to result in large-scale changes in livelihood resilience and adaptive capacity.

4. *Focused on identifying tangible avenues for supporting adaptation through disaster relief and development programmes using a catalytic synergy of community self-help groups and the private sector*. Historically, most work on adaptation to climatic

[17] Pinpointing entry points is important because if efforts to respond to climate change and variability are no different than any other development activities then there is little way for governments and donor agencies to develop focused responses. It is, in fact, a major concern articulated at international and national gatherings, where all development and poverty alleviation activities pitched by different organizations are presented as being central to adaptation. To progress, it is essential to identify those strategic activities that respond to the particular challenges associated with climatic variability and change.

BOX 1.2
Flood disaster in South India and West Nepal

An east-west band of heavy rainfall occurred place across southern India in late September and early October 2009. The highest one day rainfall of 600 millimeters triggered flood in Krishna River inundating about 100 villages in Kurnool and Mahabubnagar districts. The event resulted in death of more than 250 people and displaced 2.5 million of Andhra Pradesh and Karnataka. People were forced to live in temporary shelters. The rainfall occurred in a region known for its dry characteristics. Excessive silting in the Krishna Basin also exacerbated the flood. Debate about the role of hydro-dams in the Krishna River Basin began a new blame game between affected states following the disaster.

As flood waters inundated million acres of cropland, including sugarcane plantations and severely diminished its production. Traders estimated the flooding would hit corn output by at least one million tonnes in Karnataka and Andhra Pradesh, which account for about 35 per cent of India's total corn production. India imported rice and other crops to cover the deficits. Preliminary estimate put the loss, particularly among kharif crops, at IRs. 32,000 crores. One of the immediate impacts was increase in the price of onion, sugarcane, groundnuts and other crops in local markets.

Similarly, between the 19th and 21st of September, 2008, heavy monsoon rains lashed Far-West Nepal, soaking the Tarai districts of Banke, Bardiya, Kailali and Kanchanpur and the hill districts of Dang, Dadeldhura, Doti and Salyan. In just three days, almost all of the Tarai of Kailali and Kanchanpur districts had been flooded. According to an estimate by the Nepal Red Cross Society (NRCS), 158,663 people in 23,660 households in Kailali District and 30,733 people in 5,961 households in Kanchanpur District were affected. When people returned home after the flood waters had receded, they found that most of their cattle were dead and that 35 per cent of their paddy had been destroyed.

Data collected by Nepal's Department of Hydrology and Meteorology (DHM) showed that rainfall stations at Tikapur in Kailali District and Shantipur in Kanchanpur District recorded 282.7 and 249.9 millimetres of rainfall respectively on 20 September. The next day, Tikapur recorded only 16 millimetres of rainfall while Shantipur recorded 124.9. While such large amounts of precipitation are not unexceptional in this region, asmore roads and irrigation canals have been built in an east-west orientation perpendicular to the north- south flow of rivers, drainage has been impeded. In 2008, this obstruction became a particular problem, one which prolonged inundation. If rainfall variability and the intensity of storms increases, as climate change projections suggest they will, man-made structures that impede drainage could make populations increasingly vulnerable.

The details on West Nepal flood are based on NCVST (2009)

variability and change focused on the macro level, on national economies. Very little effort was made to link adaptation either to existing efforts in disaster relief, risk reduction, and rural development or to the market. This project is an important step in systematically establishing such links.

Because of these salient differences between this research and that of the past, its insights are likely to be novel and useful.

Relevance of the Study to Knowledge on Climate Change Adaptation

The study espoused pluralism in the policy terrain and denies hegemony of any one institution or idea. According to this concept policy-making is not merely the province of the state bureaucracy; markets and civic movements are also active in the formulation and implementation of policies. In fact, the state, market and civic movements form members of the policy triad and instrumental in making policy process dynamic. From senior bureaucrats and politicians to market players to thousands of individual farmer households—all make policy. The individual decision-making of each collectively defines vulnerability and determines whether overall resilience is depleted or enhanced. Unless actors in the bureaucracy, market and civic movements resonate, practical solutions to the issue of how to adapt to impacts of climate change will not emerge. Another need is for policy-making to address the spatial components—local, national and global—and the temporal scales—short, medium and long terms—involved in adaptation process.[18]

[18] See details in DST (2008)

2

ADAPTATION: CONCEPTUAL FRAMING

Adaptation process nedds to build on understanding of natural systems and behaviour of human agencies.

Our research used systems theory as the basis. We view the challenges of responding to climate change risk as being shaped by the complex interaction among the dynamic natural, social, economic, cultural and political systems. These dynamics are, due to their complexity, dependent on initial conditions and non-linearity, inherently chaotic and difficult to predict but are 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 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 climate change problems need to be clumsy (Verweij and Thompson, 2007), devised on implementing partial measures that are targeted towards key factors that constrain or enable humans to adapt to conditions as they emerge within the continuous process of change. It is thus focused 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 the things that can be practically done. This is the framework on which our pilot activities were grounded on.

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 *agency-driven innovation* (that is, proactive forms of innovation or actions 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.

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

[1] This section is adapted from Moench and Dixit (2007)

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.

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. This can happen if strategies are flexibilities because such strategies help build 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 important to recognise as they are 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.

Although selective pressure is a major factor, adaptation in human systems is not only driven 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 organisation (an "agent") to act and 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 occur 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'). Such difference can underlie the response agents (individuals, households, organisations, etc.) made in relation to pressures encountered during disasters.

Analysts have made distinction between autonomous and planned adaptation. It may be interesting to observe that technological development has played a key role in enabling human to adapt to various constraints they faced both at autonomous and planned scales. The difference in the two approaches is explained in Box 2.1:

BOX 2.1
Autonomous and planned adaptation

Given that stresses attributable to climate change are inevitable, a fundamental question emerges: how will those in South Asia, the Indian, Nepali, Bangladeshi farmer will adapt to the forced change? This begs a question about what adaptation mean in practical sense. Intergovernmental Panel on Climate Change (IPCC) defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." While this definition is useful, it offers little practical way to translate into the daily lives of those affected. We can make a distinction between *adaptation* and *coping* as articulated by Adaptation Study Team (2008). Adaptation is more than "coping." According to Defra (2009) "Adapting to climate change means adapting the way we do things - in all areas of our lives - to respond to the changing circumstances. It means not only protecting against negative impacts, but also making us better able to take advantage of any benefits." IPCC (2007), ISET (2008) and WB (2009) use the terms "autonomous" and "planned" adaptation, while MaGray *et al.*(2007) uses the notions "serendipitous" and "reactive" respectively. WB (2009) also uses the terms reactive, anticipatory, private and public adaptations. In well-adapted systems, people are "doing well" despite changing conditions. They are doing well either because they shift strategies or because the underlying systems on which their livelihoods are based are sufficiently resilient and flexible to absorb the impact of changes.

As a result, at its core, adaptation is about the capacity to shift strategies and develop systems that are resilient yet sufficiently flexible to enable vulnerable people to respond to change. At the same time it is also about pursuing alternative livelihood. Shifting strategy can be facilitated by planned and autonomous adaptation. The difference between the two can be conceptualised by using the analogy of an iceberg: the submerged invisible part representing autonomous adaptation is much larger than the visible tip above the water level which is akin to planned adaptation.

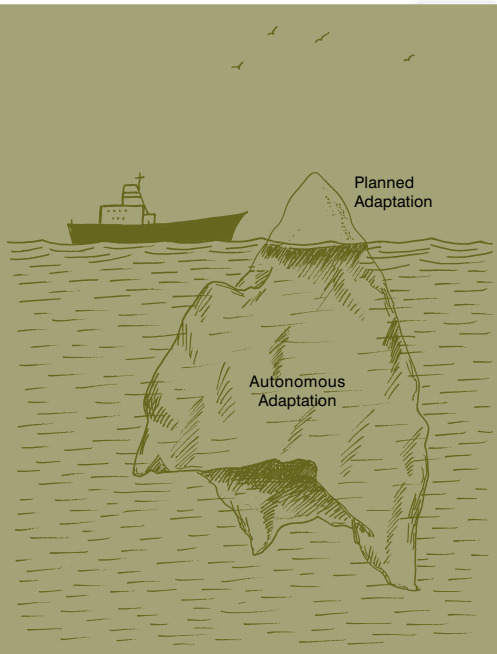
Planned Adaptation: Planned adaptation includes programmes and projects that governments, NGOs, and international donors implement as a result of specific climate impacts and vulnerability assessments. Planned and autonomous adaptation can be further conceived as attributed planned adaptation and systemic adaptation.

Attributed Planned Adaptation: Such planned adaptations are generally made to respond, to predict impacts on ecosystem and hydrological system and to minimise human vulnerability by focusing on sectoral interventions, such as those related to water management and flood control. Attribution of impact to climate change is necesary. It is the result of deliberate policy decision taken by government or public sector agencies.

Systemic Adaptation: Systemic adaptation may not necessarily require attribution but involves creating arrangements that enable people to switch strategy and doing well.

Autonomous Adaptation:
Autonomous adaptation includes actions that individuals, communities, businesses and other organisations undertake on their own in response to the opportunities and constraints they face as the climate changes. Autonomous actions are individual or collective responses, almost entirely in the poorly recorded informal sector. These may involve changes in practices and technologies, diversification of livelihood systems, access to financial resources (e.g. micro-insurance, micro-credit), migration, reconfiguring labour allocation or resource rights, and collective action to access services, resources or markets. Social capital and access to skills and knowledge can be particularly important to enable these responses.

Autonomous adaptation takes place at the community and household levels while planned adaptation includes those strategies and actions initiated by a government to shape its policies, programmes, and projects in response to global climate change impacts. Most planning decisions work in the long term and are path-dependent, whereas autonomous or indigenous adaptation is



Adapted from NCVST (2009)

short-term and spontaneous as communities or households respond immediately to the social, political and institutional stresses associated with the changing climate. The market, both formal and informal, is an important avenue where the response is autonomous; and many of the opportunities are visible and available but at the household's level it is often invisible or beyond the ken of national or international level of planning.

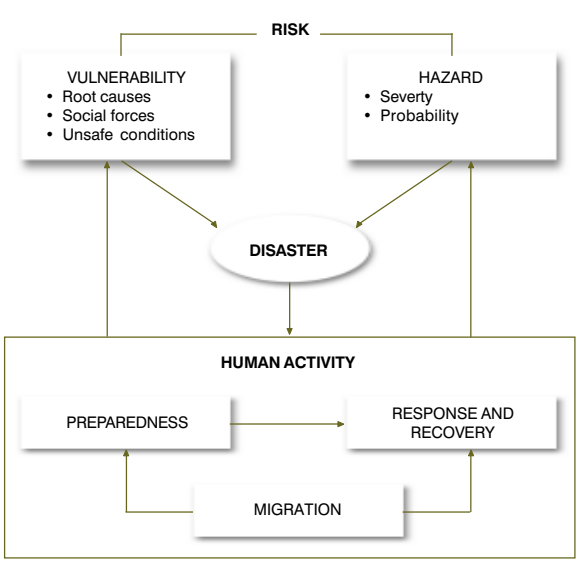
The massive rural outmigration seen in Nepal during the last decade is one such example of market provided opportunity for strategy switching. It was enabled by one simple policy enacted by the government at a systemic scale. In the mid 1990 Nepal government decided that the office of the Chief District Officer in each district would issue passport. Earlier only the Ministry of Foreign Affairs in Kathmandu had that responsibility. With passport being issued at the district centres increased both access and responsiveness enabling strategy switch. It must however be mentioned that both pull and push factors are operational in pursuing migration as a strategy. Autonomous adaptation may be triggered by market or welfare changes (USAID, 2009).

Conceptually, adaptation process to climate change impact is closely associated with reducing the risk of climate induced disasters. 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 and population living within them 'adapting to' the types of events that can cause disaster.

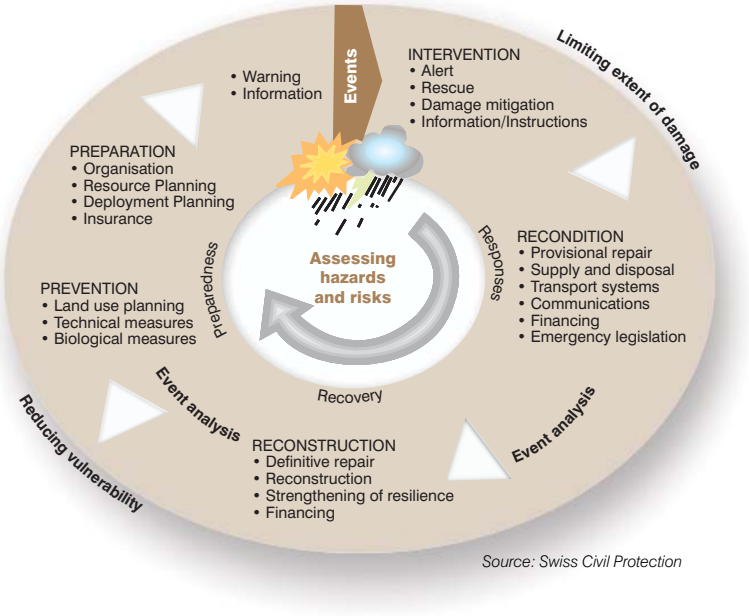
Hard and Soft Resilience

Disaster risk reduction interventions, particularly those focused on physical infrastructure and assets such as buildings, often focus on reducing fragility. This is, for example, the case with incorporating earthquake strengthening into building codes or raising river levees to contain higher flood levels. In many cases the goal is to ensure structures or the assets they protect suffer minimal or no damage by events of specific magnitude. When design events are exceeded and levees or dams fail, the result is often catastrophic. Many times however failure occurs even though the so called threshold is not reached. Such catastrophe was experienced in 2008 August when the Koshi embankment breached (Dixit, 2009). The breach was an outcome of institutional failure, not by any climatic hazards. 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 levees are used to protect agricultural lands while higher levees protect urban areas or sites of strategic importance such as airports. Often in such cases, lower level embankments breach during large flood events and reduce pressure on embankments protecting more valuable

FIGURE 2.1:
DISASTER CYCLE



Source: Etkin (1999)



Source: Swiss Civil Protection

assets. Under these conditions, asset losses are often step functions of distinct breaks at different event magnitudes. These above discussion thus had to conceive resilience in two broad terms: hard and soft resilience. Each is defined as follows.

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 risk reduction context, resilience is 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. In case of flood such concept translates in practical terms to, in case of embankment withstand a flood of higher probability than it was originally designed to withstand.

But as higher than the designed flood is likely to occur, embankments breach can, as mentioned above, cause major catastrophe. The failure of embankments in New Orleans is a care in point. The hazard in this care was category V hurricane. The logic also stands in care of flood and suggest catastrophic scenario as climate change could result in extreme events. 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. Concepts such as *soft resilience* are well established in scientific communities working on system dynamics. The *Resilience Alliance*, one of the main forums for discussion within these communities, has defined resilience as:

> *"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".*

Since humans are part of the natural world, linking natural and social system would make sense to expand the notion of resilience and adaptation. We depend on ecological systems for our survival, though we continuously impact the ecosystems in which we live from the local to global scale. Resilience in social systems implies the added capacity of human to anticipate and plan for the future as a property of the linked social and 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 in 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 and
- The ability to build and increase the capacity for learning and adaptation."

The evolution of effective strategies for reducing disaster risks and adapting to climate change represents a fundamental challenge for human society. Our common future in many ways rests in our ability to make such a switch. We need to systematically document some responses targeted at specific risks or changes in climate, as they provide us lessons on how to deal with similar events in future. Two issues uncertainty and time scale present fundamental challenge.

There is substantial uncertainty regarding how changes in climatic conditions will affect local areas (See box 2.2).

The question therefore is what the risk will be? Furthermore, major 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. It must be recognized that the ability to adapt and respond effectively to surprise and change, 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. Our study endorses this argument. It is necessary to target and minimise first order risks that climate change entails. However it will also be necessary to focus on the systemic elements. Actions that strengthen such elements may, prove far more effective than generic attempts to target first order risks. Another question is whether strategies need to be devised for short, medium or the long-term.

In addition to underlying systems, the post-disaster context represents 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 that clearly indicates the high vulnerability of populations or specific groups in coastal and other regions, responses are essential. 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 in response to sea-level rise or the likelihood of increases in storm activities. 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 level, change will occur in response to pulses but even then the pace would be shower. The aftermath of Tsunami can be taken as an example. As a result building understanding and identifying the types of changes that can be both technically effective and socially viable represents a major potential avenue for responding to hazards and the risks associated with climate change.

Four issues related with the conceptual concerns are vulnerability, communications Shared Learning Dialogues (SLDs) and ecosystems. In the following sections we present theoretical aspects of these issues as we attempt to device practical course of action to deal with local level activities related to climate change adaptation.

Vulnerability: Concept and Definition

The concept of vulnerability is at the heart of our aim to understand how communities and natural systems, institutional structures and social relationships are affected by climate variability and disaster risk. While the physical scientists and engineers have equated vulnerability with physical exposure to extreme events and adverse outcomes, social analysts have seen it as failure of entitlement to resources, and structural factors making certain

BOX 2.2
Risk and uncertainty

We make decisions to bring about some future benefit to someone or something. All decision-making involve choices (e.g. whether to act or simply to do nothing and, if we do act, whether to implement policy A or B or C) (UKCIP, 2003). If we knew what the future holds, decision-making would be straightforward and simple. However, the real world is complex and changing; the future, uncertain. The concept of uncertainty can be understood better in relation Knight's pronouncement of 1921:

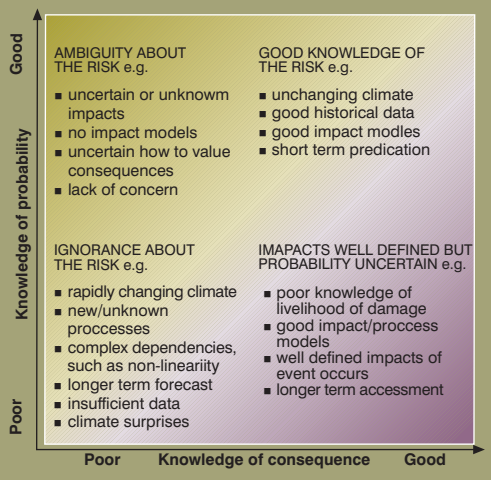
1. If you know for sure what is going to happen, that is *certainty*.
2. If you do not know for sure what happen, but you know the odds, that is *risk*.
3. If you do not even know the odds, that is *uncertainty*.

Uncertainty exists either when there is a lack of knowledge concerning outcomes or when our knowledge of risk is imprecise, i.e. when the probabilities and magnitudes of either the hazards and/or their associated consequences are uncertain. However, even when we our knowledge of these components is precise, there is still an element of uncertainty as outcomes can only be determined probabilistically. Making a decision involves exercising our judgment about these uncertainties. For this reasons, making a well-informed decision entails identifying the sources of uncertainty and understanding how they contribute to the decision, and managing uncertainties within the assessment and decision-making process. While not all decisions produce the benefits that were intended, any decision should, even with the advantage of hindsight, be justifiable on the basis of the knowledge available at the time the decision is made.

Responding to the impacts of climate change requires that we assess risk as a combination of the probability and the magnitude of a consequence. Risk considers the frequency or likelihood of occurrence of certain states or events (often termed 'hazards') and the magnitude of the likely consequences for those exposed to these hazardous states or events. Because climate change affects hydrological systems, it changes the character of the hazards faced.

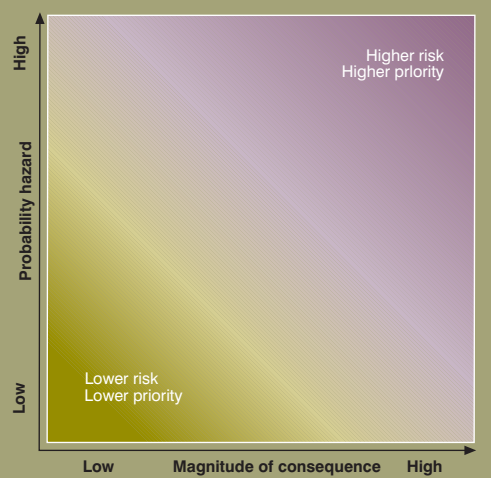
UKCIP (2003) explains risk analysis succinctly as the process by which knowledge concerning the probabilities, uncertainties and magnitudes of future events is brought together, analysed and organised by a decision-maker. Risk analysis includes risk assessment, and the identification and assessment of alternatives. Assessing risk can involve using both *quantitative* or *qualitative* techniques or information in order to describe the probability of risk. Together, they help us estimate risk with some degree of confidence.

Social scientists also use the concept of risk as a lens to explain the strategies that different worldviews adopt. Those who espouse hierarchy strategise to minimise risk, while egalitarians assume alarmist positions which highlight risk and individualists take risk. Fatalists, for their part, absorb risk.



Uncertainty is a result of a lack of knowledge of either the probability of an event, or its consequences. Where we have good knowledge of both, then we are able to characterise the risk, both quantitatively and accurately (top right). Examples of some of the factors that contribute to uncertainty about the probabilities associated with future climate statistics, and the consequences of a changed climate, are indicated.

Adapted from Willows and Connel (eds. 2003)



Risk depends on both probability and consequence. Climate represents a present-day hazard that we manage based largely upon past experience. Global warming may change the future probability associated with a hazard of a particular magnitude. thereby affecting the probability associated with particular consequence. For example, intense rainfall may become more frequent. leading to an incerease in flooding risk. The aim of climate change risk assessment and adaptation decision-making is to asess and manage the risk to defined receptors of exposure units.

Adapted from Willows and Connel (eds. 2003)

groups differentially disadvantaged in the face of disasters (Adger, 2006). Some have attempted to bridge the gap between the physical and social perspectives on vulnerability by proposing the concept of a 'vulnerability of place' where biophysical exposure intersects with political, economic and social factors to generate specific configurations of vulnerability (Cutter, 1996; Cutter *et.al.,* 2000). We define vulnerability as susceptibility to suffer damage from an environmental extreme and relative inability to recover from that damage (Mustafa, 1998, McCarthy, 2001). Furthermore, we conceive of vulnerability to be more of a chronic state of survival rather than only an outcome of environmental extremes. Our emphasis was on defining the metrics for recognizing, measuring and ultimately addressing vulnerability as defined above, instead of revisiting the well known basics. To do so we drew upon theoretical insights from vulnerability research coupled with empirical research, in the four sites by measuring vulnerability index. This process is further explained in chapter 4.

While discussing vulnerability, it is important to highlight its interface with poverty and gender, caste and its social construction. In South Asia, vulnerability should also be analyzed in the context of the opportunities and risks offered by globalisation as it intersects with gender, caste and, increasingly, religion. Technological and economic globalisation processes are intensifying and, in combination with demographic changes, increasing consumption and climate change, altering livelihood systems. The livelihoods of the vulnerable sections of the population, particularly the poor, are in the process of undergoing changes that may further increase their vulnerability. While we recognise the importance, we have not explicitly considered globalization and technological vulnerability in our study. It is however important to recognize that poverty, gender, caste and social construction underscore the scale of vulnerability in the case study sites and it will be relevant to discuss them further. The other aspect is capacities and capabilities.

Poverty and Vulnerability: Poverty is a core dimension of vulnerability: All poor people are vulnerable, but not all vulnerable people are poor (ActionAid, 2005). 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. The poor, however, have little access to alternative security mechanisms or safety nets (except for family and kin relations) and are pushed into slums (a 'livelihood resource') or to live on and cultivate in slopes prone to landslides (Wisner *et al*., 2004). Moench and Dixit (2004) have found that 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:

Gender and Vulnerability: Wisner *et al.* (1994, 2004) acknowledge that vulnerability is structured by relations of gender and power intersecting at different institutional sites. In South Asia, as well as most parts of the world, 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). 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 a non homogenous phenomenon and disasters can affect different social groups of women or girls as differently as they may to different social groups of men or boys. Emerging evidence, 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 group discussion in the flood, and increasingly drought prone, village of Sonatikar in Gorakhpur District, Eastern Uttar Pradesh and Nepal Tarai, women described their vulnerability to food insecurity with the following simple phrase: 'half full stomachs'.[2] 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);
- employment and other income-generating opportunities;
- opportunities that can build their skills and capacities such as education, or ensure a better quality of life;
- 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.

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).

Caste and Vulnerability: The complex social hierarchy of caste which characterises community relations in case study sites determines not only who has access to 'common' resources such as water, but equally determines where people live in a village community and the kind of educations, livelihoods and other entitlements they have access to. 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 – 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

[2] See Ahmad and Mustafa (2007)

(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 because of the practice of female seclusion or *purdah.*

Social Construction of vulnerability: Vulnerability is also related to people's perceptions. 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). Such a social constructionist 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. 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 'objective reality' (i.e. climate change) is like throwing the baby out with the bath water as it does not help us to move the agenda of practice on disaster risk reduction or climate adaptation forward (see Wisner *et.al.,* 2004). However, the question is not whether climate change exists or not–there is enough scientific evidence and indigenous knowledge/reflection on the impacts of changing climate and weather patterns – but is to dig deeper into differential (subjective) understandings or perceptions of lived and experienced climate change reality.

Given the above context, the working definition of vulnerability for our case study following Cutter (1996), Mustafa (1998) and Adger (2006) is 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. Table 2.1 summarises these different aspects of vulnerability.

Capacities and capabilities: Study of vulnerability should also include capacities which are the characteristics of communities and people, which can be used to respond to and cope with disasters. The concept of capacity emerged in response to the supposed negativity of the term vulnerability which suggested that people are passive victims rather than recognising the inherent capacities that make them competent to resist hazards (Cannon *et al.*, 2003). 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

TABLE 2.1:
DIFFERENT 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) ■ Governance and decision-making (conflict resolution)
Psychological/ Attitudinal	■ Resistance towards change ■ Dependency, trauma (or lack of social/ physical mobility) ■ Lack of self-autonomy

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 levels.

While the above discussions encapsulate the notion of vulnerability as it understood, the nature of impact of climate change likely to produce at different levels, our challenge was to devise ways and means to find who in each of our study sites were vulnerable and to what factors. This identification was necessary to situate individual and households in each site who could be the target of the conceived piloting intervention. We needed both conceptual clarity and a process that would include both qualitative and quantitative aspect of determining vulnerability. A vulnerability index, if could developed, would help assess in each site the number of families or household desegregated with the help of the index. It could also provide a baseline on which similar methods could be used to determine the extent of vulnerability, say after a gap of two years. Though limitations must be recognised, such an approach could assess changing vulnerability in its dynamic form. In Chapter 4 we provide detail methodology we followed in assessing vulnerability.

It was also necessary to establish a procedure, as per our clumsy approach create a non-hegemonic space in which the top down model could interface with the local approaches. Clearly we needed an interactive procedure to take pilot activities forward. This process was conceived as Shared Learning Dialogue (SLD's). In the following section we provide theoretical realm of the SLD process.

The Shared Learning Dialogue Process

This process was necessitated to create an engagement between the rationalist approaches and the so called indigenous methods. The tension between rationalist expert and local knowledge has a long history of research (see figure 2.1). Such is been used 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 normal disaster risks and those emerging as a consequence of climate change. It also sets the stage for informed decision-making (see figure 2.2)

This is not a new tension. In 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. Initially, most development was conceptualised primarily as

FIGURE 2.2:
SHARED LEARNING PROCESS

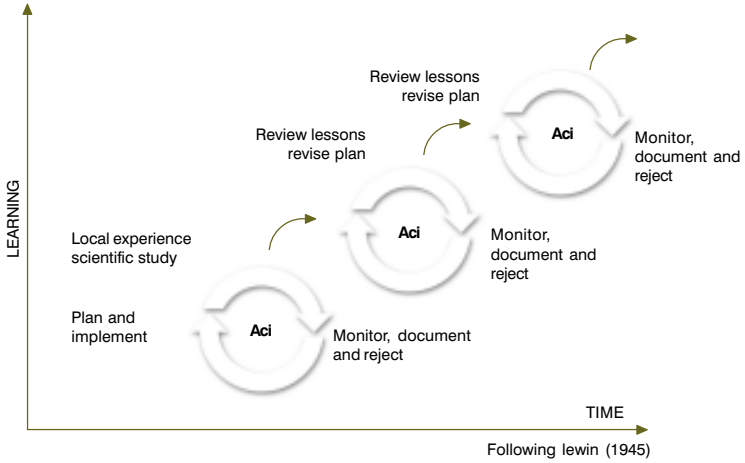
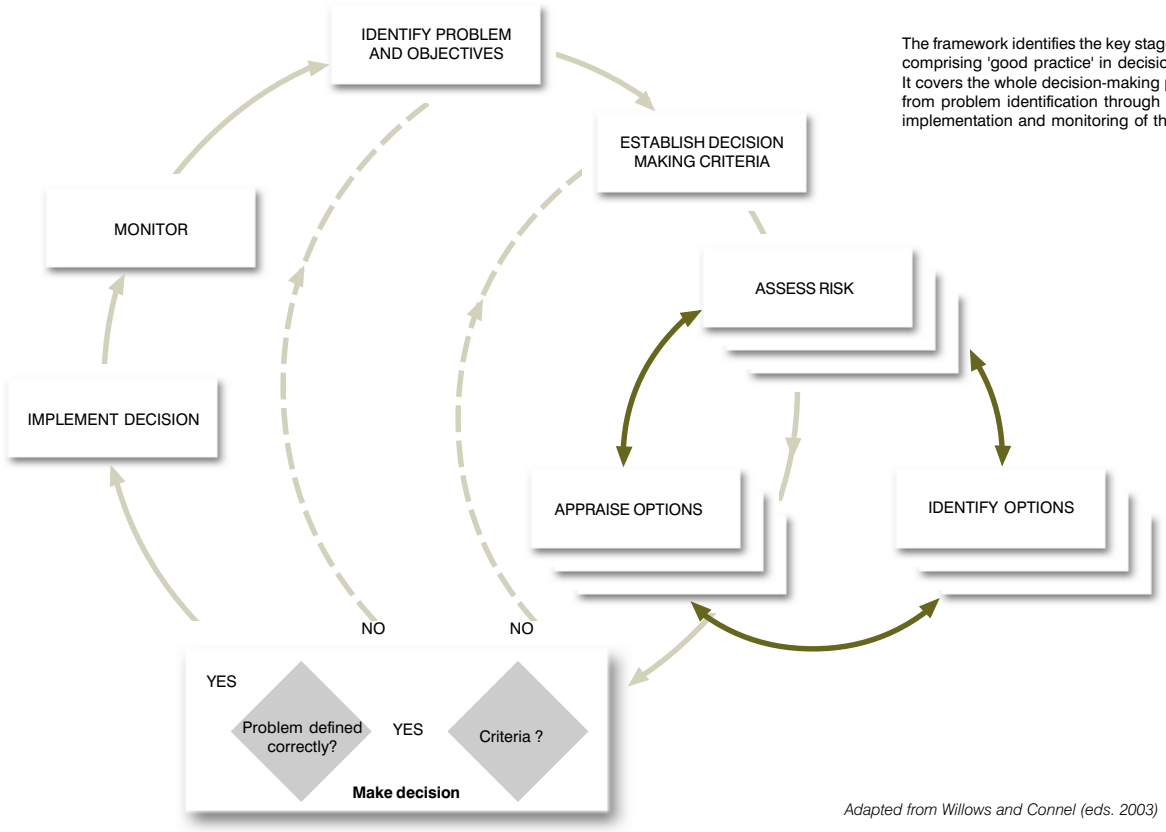


FIGURE 2.3:
FRAMEWORK TO SUPPORT GOOD DECISION-MAKING IN THE FACE OF CLIMATE CHANGE RISK



The framework identifies the key stages comprising 'good practice' in decision-making. It covers the whole decision-making process, from problem identification through to implementation and monitoring of the decision.

Adapted from Willows and Connel (eds. 2003)

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. These were delivered to rural areas through agricultural extension services and replaced lower value (defined primarily in terms of production) traditional varieties.

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

In response participation emerged as a strategy to bring local inputs into what were still largely and centrally conceptualised driven processes. This was accompanied by techniques such as 'rapid rural appraisal' – which 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?) concept such as stakeholder 'ownership', community-driven development emerged as avenues for strengthening the locally rooted nature of development processes. This shift was accompanied by many techniques to decentralise the design, implementation and control over development and natural resource management activities.

The emergence of locally driven strategies and forms of organisation has not replaced centrally driven strategies. In many fields – such as water and disaster risk reduction – 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. There are not only the two completing world views. The third view is what we can call Reaganite and Thatcherian worldview of dependence on virtues of free and unbridled market. The competition is as much driven by conflicting visions of what life *should be*, what the state *should do,* what the market *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. It is important to emphasise that this competition is as much *ideological* as it is strategic.

All three state/bureaucracy-driven, community-based strategies and market based private sector strategies are characterised by conflicting ideologies as we seek answer to the question 'what works' best. The current global debates over privatisation of service delivery organisations (such as water and power utilities) by taking away the role of the state (read government) from such responsibilities provides only partial view of the story. The choice is not between one or the other, both the state and market are necessary. In addition the third worldview represented by community based strategy make policy triad stable. In somewhat indirect manner, the competition is also characterised by tensions over migration–the appropriateness of a strategising individual moving to where jobs or livelihood exist. To put it dramatically people "vote with their feet" when pushed and stressed beyond a point.

The above discussions suggest three core points that have direct relevance for the development of strategies for responding to climate change that underpin the shared learning dialogue (SLD) methodology. The nature of differing perspectives is already highlighted in box 2.2:

1. Perspectives on the role of states, communities and private sector organisations are influenced by conflicting and alone provide only a partial worldview.
2. Each espouses a set of biases, which are defined against the biases of others and sustained by aggressive self-definition. Also each group shows a preference for a particular set of institutional forms as well as the kind of knowledge and technological choice that goes with it.[3]
3. The logic underlying different modes of organising generates different perspectives and response strategies in relation to perceived constraints and opportunities. Each worldview challenges the specific approach formulated by the other but also a blind spot.
4. None of the strategies pursued by each can, by itself, address the challenges inherent in reducing disaster risk or responding to climate change.

In order to develop effective strategies for responding to disaster risks and the changes likely to occur as a consequence of climatic

[3] This discussion is based on Douglas (1999). *Ibid* Dixit (2001) for an application of the concept to the water debates in South Asia that led was also central to the formation of the World Commission on Dams (WCD, 2000).

change, the gaps created by differences between expert and local knowledge and the differing ideological histories of development need to be bridged. This process needs to occur over long time periods as knowledge on climate, and those generated by world views of the state market and community groups risks and effective response evolves strategies. 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 scales from local to global will be essential.

Shared learning dialogues were intended to consist of relatively informal roundtable dialogues among groups involved in research and external governmental, non-governmental and private sector organisations working on related issues. The goal of these meetings were to ensure that cross-fertilisation occurs among 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 strategy would ensure that the capacities and ideas generated during the study could be incorporated as core parts of the wider knowledge and implementation environment. This approach is different from conventional ones 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.

Although the need for "shared learning" was recognised at the outset of the programme as required for the identification of practical responses to deal with impacts of 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 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 that 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. Our research pursued this method and has added value to better understand the contours of this process. This recognition would lead us to the next important issue of communication as we attempt to adapt to impact of climate change.

Role of Communications systems

Improving understanding and specific role of integrated multi-purpose communications systems in adaptation, resilience and risk reduction was a major component of the project. This section of study focused on improving understanding of the multiple roles that effective communications systems (packages of technologies, interfaces and social interpretive frameworks) play as a foundation enabling individuals, households and communities to adapt and develop livelihoods that are resilient. The project supported research with objective of improving understanding of the operation of existing communications systems and identifying points of entry where enhancements (either using existing or new technologies) would increase

BOX 2.3
SLD and communication

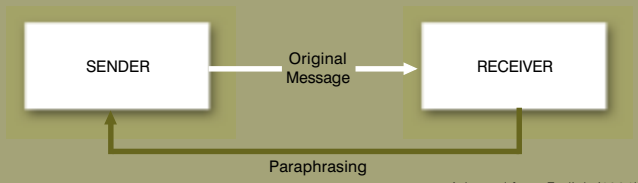
Consideration for organising local level SLD

1) An open place or hall especially in summer and winter with good environmental and sanitary condition;
2) Located within commutable distance for participants to travel so as to optimise travel time;
3) Women participants need special consideration; and when they cannot commute to places out side SLD must be held at site/village; and
4) Facilitators need to communicate in language that is understood by participants.

Communication seems like a simple process of sending and receiving infomation among people.

But it is one of the more complex things that people do. We may think we are sending a clear message, but the person who receives it hears it differently from the way it was intended. Sometimes we are distracted and do not "hear" or listen very carefully. One way to ensure that communication is really taking place is to use *paraphrasing.*

Paraphrasing is "capturing the meaning of a ststement and saying it back to the other person in your own words";



Adapted from Frelick (1991)

resilience and adaptive capacity. Within this larger research and piloting element we focused attention was, early warning through communications systems that are 'alive' because they are in daily use in the communities.

Adaptation to climatic variability and change is perhaps the greatest challenge facing humanity in the coming decades. This challenge has numerous dimensions, many of which are addressed in the accompanying full program description. One of the most important challenges will occur in flood plains and coastal areas that are particularly susceptible to flooding and extreme storm events. Many of the impacts within these and other areas will depend on the manner in which basic ecosystems are managed. These systems may contribute to direct protection by, for example, providing areas that break the force of storms or absorbing, channeling and allowing the drainage of floodwaters. They also often represent a key ingredient for livelihood diversification by, for example, supporting fisheries and other natural resources or enabling modern industries such as tourism. Impacts will also depend on the degree to which vulnerable populations are able to obtain, correctly interpret and act on advance warning of impending flood or storm events. Early warning systems that are 'alive' serve multiple functions and are in daily use, are increasingly recognized as a critical factor influencing the economic and human impacts of climatic variability and change.

The nature of such systems, the degree to which different sections of communities have access to them and the way warning functions relate to the cultural and behavioral patterns within groups are all critical factors. Furthermore, communications systems are not a function of technology and access alone. Information flows in cascades and chains between its point of origin and its ultimate use. Such cascades often involve multiple actors and multiple points where information is interpreted, reformulated and transmitted to the next set of actors. How these system processes occur is as important as the technological 'hardware' (whether electronic or via the original 'word processor' – i.e. pencil) that performs the physical processes of information transmission. Information flow is

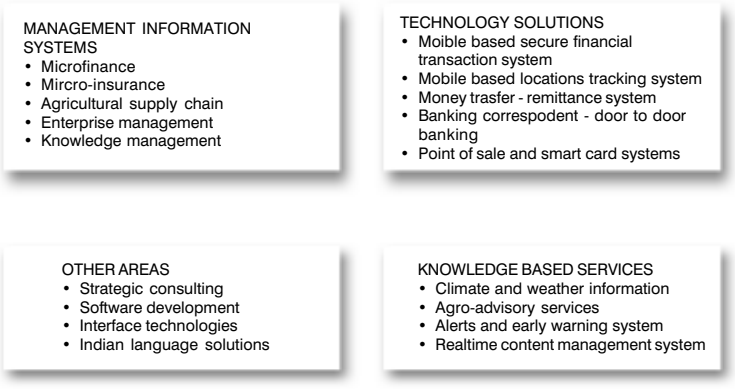
a process that depends on a variety of institutional, perceptual and other software as well as the static or interactive interfaces through which potential users interact with stimulus. Because potential actors along a chain of information transmittal often differ culturally, educationally and socially, the software and interfaces required for effective communication will often differ as well.

Beyond the complex process of information transmittal within communication systems, it is important to recognize that such systems can influence vulnerability through at least two paths – that is through the direct early warning function they provide and through the way they indirectly enable the development of diversified resilient livelihood systems. Understanding these roles and how the nature of communications systems relates to behavior, resilience and vulnerability within different sections of society will be central to the development of effective strategies for adapting to climate change.

As the brief discussion of environmental management and communications systems above illustrate, the degree to which different groups are vulnerable to climatic variability and change is far from uniform and will be affected by multiple factors. In global debates over the impacts of climate change there is often a basic assumption that the poor are the most vulnerable. While this may be true as a broad generalization, it is far from accurate in many local situations. Riverfront and coastal property is often among the most valuable and, as the numerous tourist deaths in the recent tsunami illustrate, can generate patterns of vulnerability that affect the wealthy as well as the poor. On a different level, access to key assets that influence vulnerability may be heavily influenced by gender or social position. In the case of communications, for example, men may control the cell phone, TV and radio. They may also use these communications systems for different purposes and respond in different ways to warnings or other information transmitted over them. Perhaps more subtly, communication systems are often fragmented by the cultural divides. Information must cross as it flows between source points and potential users.

The case of climate and weather information is, perhaps, one of the most problematic. Information on climate and weather is conventionally generated by atmospheric scientists who differ in fundamental ways from potential users such as illiterate fishermen in vulnerable coastal regions. Such high-level actors often view 'the problem' of information communication as a top-down process of packaging information in ways that are accessible to 'the masses.' They have little cultural resonance for the array of traditional information sources that local communities often utilize for monitoring local weather and climate. As a result, the gaps in communication systems often have as much to do with the cultural and psychological divides between communities of actors as they do with access to or control over a given piece of technology. Similarly, where

FIGURE 2.4:
SECTORS INVOLVED IN COMMUNICATION



Source: Magotra and Carter (2009)

the environment is concerned access to — and the management of — fisheries, forests and other basic resources are often influenced by both perceptual divides between local and external actors (fishers and scientists) and by divides between caste groups or other traditional social divisions within communities.

The types of divisions mentioned above in relation to both communication systems and the environment create a mosaic of vulnerability that may be influenced by common elements (such as the degree of access individuals have to resources in general) but that shifts with economic, demographic and other social changes. As with ecosystem management and communications, understanding the common factors contributing to differential vulnerability and the manner in which such factors evolve in specific contexts is also central to the development of effective strategies for adapting to climate change. Despite its importance in the case of ecosystems management, communications and vulnerability, improvements in understanding are far from the only requirement for the development of effective response strategies. Testing potential strategies in field locations, communicating insights and the results of testing to local, regional and global actors is critical. In addition, the elements highlighted in this introduction should not be viewed in isolation. While they are of direct relevance to global debates over adaptation on their own right, they are also part of a larger picture.

Specific research questions that were and are being addressed in this component of the program related to communication systems were as follows:

1. What is the current structure (generation and delivery) of communication systems (hardware and software) for early warning, weather, climate and livelihood information in field areas and how does that relate to national policies for weather, climate and early warning information dissemination?
2. What are the specific gaps in communications systems that limit access to or the usability of information for different groups within the case study communities?
3. How specifically do any gaps that are identified in communication systems limit the ability of communities as a whole or different groups (caste, gender, economic) within communities to adapt or develop livelihoods that are resilient to climatic variability and change in case areas?
4. How identifying interfaces could help communities comprehend information across socio-cultural, educational and economic barriers?
5. What are the potential interventions within communications systems that could address key gaps and how successful are such interventions when they are implemented on a pilot basis in case areas?

Adaptive Ecosystem Management

Earth's natural ecosystems provide food, freshwater, fuel-wood and genetic resources that help shape human well being. Ecosystems also help in regulating, and moderating the impacts of inter-annual variability of rainfall and hazards such as floods, droughts and cyclones. Local ecosystems are nested within a larger macro-level ecosystem and any disturbance in the smaller parts can create imbalance in the whole ecosystem. A comprehensive, systemic, yet detailed view of ecosystems, ecosystem services, interlinkages between ecosystem functions and human and natural disturbance is necessary to avoid damaging the fine balance that enables an ecosystem to be healthy. For

BOX 2.4
Ecosystem services in blurring rural urban continuum

The Millennium Ecosystem Assessment (MEA, 2005) has defined an ecosystem as 'a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit' and ecosystem services as 'the benefits people obtain from ecosystems, including provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits'. Humans depend fundamentally on the flow of these goods and services though culture and technology provides some buffer against environmental changes. Such changes in service affect human well-being through impacts on security, the basic materials to support a good life, health, and social and cultural relations and such changes disproportionately affect the poor. Inter-linkages between ecosystem services and human well-being were summarized in the MEA by the accompanying diagram.

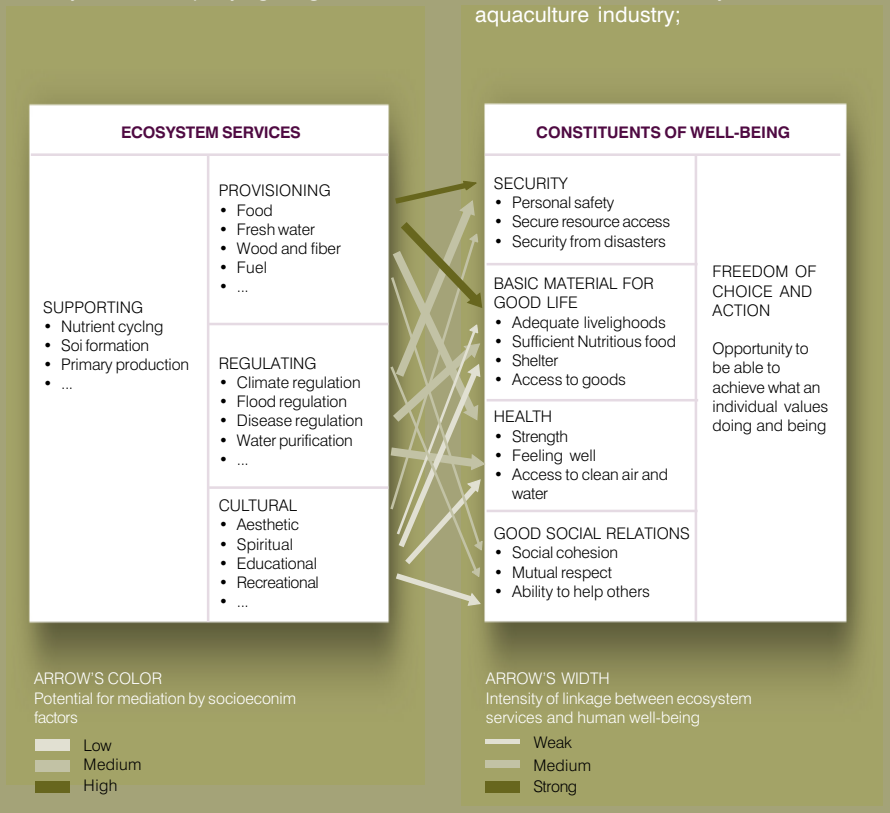
The MEA has concluded that 60 percent of the world's major ecosystem services have been degraded over the past 50 years and is expected to increase over the first half of this century. The cause for this degradation is clear. Human societies have taken ecosystem services for granted, in large part because decision-makers lack sufficient information, incentives, rights, management processes, and accountability for sustainably managing ecosystems. Population growth, urbanization, land-use change, and other drivers contribute to continue degradation.

Climate change further contributes to the degradation of ecosystems and their services due to

- declines in fresh water availability;
- decreasing crop yields;
- drought and flooding (water regulation) due to the accelerated melting and receding of glaciers worldwide;
- shifts in optimal areas for forest growth;
- sea level rise and ocean acidification, which could seriously affect the aquaculture industry;
- perturbations in ecological interactions, including competition, disease and host-parasite interactions, pollination, predator-prey interactions and herbivory; and
- negative effects on high-conservation-value ecosystems and biodiversity (cultural services).

Overall, the impacts will affect good health, good social relations, and human security. As a result people more directly dependent upon ecosystem services-typically, the poor are losing the foundation on which their livelihood depends. The blurring relation between urban and rural region is introducing new forms of stress on ecosystems as the change process proceeds. The ongoing economic and cultural globalization and socio-political processes are new stress drivers. These drivers have brought about rapid social, institutional and livelihood transformation across broad areas. Migration and mobility have increased and market-centric livelihoods now dominate in many regions that were once dominated by rural agricultural or natural resource based socioeconomic systems. It is the mixed-economy region between "rural" and "urban," captured by the Basha Indonesia term desakota (meaning village-town) (McGee, 1991), where the trends in ecosystem stress can best be observed. These regions are linked to major urban centres by cheap transport axes where much more intense commercial agricultural and non-agricultural economic activities take place than in purely rural areas.

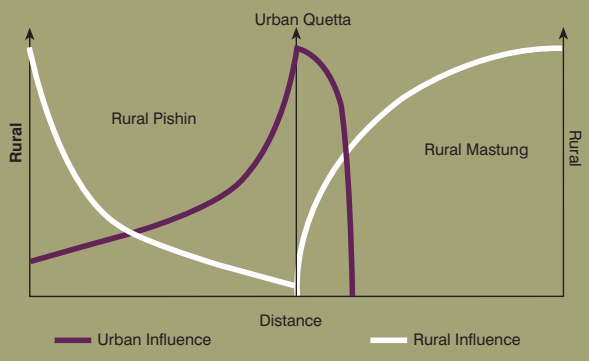
The desakota phenomenon encompasses more than the term "peri-urban." It is an outcome of the interaction between rural and urban production and institutional systems. The rural is characterised by livelihood systems based on primary products production and support services, mostly strong informal institutions and technologies drawing upon local level human resources for their production and maintenance. The urban is characterized by secondary level production and tertiary level service sector based livelihoods integrated into national and global level economies, relatively more efficacious formal institutions of varying



Source: Millennium ecosystem assessment

strength, and finally technologies drawing upon national and global level human resources.

As transitional environments, the concepts that underpin most approaches to the development of institutions for ecosystem management may be less applicable in the desakota region. Community-based approaches, one of the centre pieces of development strategies in most rural regions, are heavily challenged when communities are no longer strongly interdependent and geographically defined. This raises two questions. First, issues such as increased mobility, the diversification of livelihood and income options, changing social relationships raise questions regarding the viability of community-based approaches. More urban approaches to the development of institutions for ecosystems management are less applicable in the desakota context. Formal management organizations (such as municipal authorities, water districts, forest and park departments, utilities) are generally either weakly established or function as "enclave" institutions-structures that function in physical or social isolation from the realities of daily life for the populations living in the desakota region. Instead, desakota environments are characterized by highly mobile informal institutions-such as informal water markets-that focus on provisioning services but less often on management of the ecosystem or resource base itself. Notionally the schematic diagram in figure conceptualised in the context of the Pishin Mastung corridor in Balochistan illustrates the trajectory of influence of formal urban and rural informal and customary institutions across the rural urban spaces.



Source: DST (2008)

Our approach to adaptation to climate change impacts and reduce human vulnerability needs to re-imagine the interdependence among the changing rural urban divide, the ecosystems and the services they provide (DST, 2008).

many in South Asia whose livelihoods are primarily dependent upon natural resources and ecosystem services, such as agriculture or aquaculture, the health of their local ecosystem is tantamount to basic survival. Policies of the government related to ecosystem management and enforcement of those policies can serve as critical starting point stabilizing or destabilizing ecosystems.

In particular, healthy ecosystems and vibrant ecosystem services will become increasingly important in supporting adaptation as the climate becomes less predictable due to anthropogenically induced climate change. The Millennium Ecosystem Assessment (2005) concludes that, unless we take action to mitigate the decline in ecosystem services, the costs to society will be substantial. The challenge to achieve these goals in the context of changing climate will be even greater. While a number of measures need to be taken at the national and global levels, at the local level, sustainable management of environmental natural resources will enable people to build resilience and adapt to climate change impacts. To meet this objective one needs t o take a more systematic approach to examining the inter-dependencies among people, climate and ecosystems. The Ecosystem Approach takes an integrated management of land, water and living resources to promote conservation and sustainable use in an equitable way.

The impacts of projected climate cut across different sectors, communities and natural systems. Some of them are:

- Reduction in the availability of freshwater and adverse impacts on agriculture and food security due to a decline in rainfall in some seasons of the year, greater rainfall variability and higher frequency of extreme rainfall events in the monsoon season
- Boundary shifts for different forest types,

with consequent implications for species diversity and forest-dependent communities
- Adverse impacts on natural ecosystems such as wetlands, mangroves, coral reefs and mountain ecosystems, affecting the food and livelihood security of populations dependent on those resources
- Threat of sea-level rise along coastal zones with implications for increased flooding, inundation of agricultural land and problems of water and sanitation, and,
- Threat of increased inland salinility due to sea-level rise along coastal zones

Our study sought to scope and pilot activities that could improve the health of site-specific ecosystems and the latter's ability to provide goods and services in the four project .areas. The study involved, apart from other facets of adaptation, the following board themes of:

1. An assessment (quantitative and qualitative) of the conditions of ecosystem service in pre, during and post-disaster situations in each area;
2. Trends in ecosystem services in the past and reasons for the trends;
3. Identification of drivers of changes in ecosystem services (for example, demographics, technology, land-use, pollution, etc.)
4. Understanding systems (technology, institutions, etc.) that help in resource-access;
5. Understanding patterns of access and consumption across various community groups;
6. Demand management systems (traditional, etc.); and,
7. Policies and programmes for management of ecosystem services

While small actions at the local level cannot make much difference until measures are taken to bring about change in the macro-ecological and systemic levels, we attempted to demonstrate on ground adaptation activities that could be replicated at a larger level. Activities were selected after holding SLDs at various levels including the affected communities and other relevant government and non-government agencies.

Overall our study made attempts to explore adaptation as strategy switch using the shared learning dialogue process. The study was also an effort to disentangle the relationship between development and adaptation while feeding the insights into the ongoing discourse. We revisit some of these questions at the end in chapter seven.

3

PILOT PROJECTS IN HOT SPOTS

A hotspot to climate vagaries overall, South Asia has many hot spots

South Asia as a whole is a "hotspot" as far as the impacts of climate change is concerned. ISET's 2008 report defines a hotspot as an area where (1) multiple considerations make it likely that the impacts of climate change will be large-scale; (2) multiple factors contribute to vulnerability and appear likely to limit the ability of local populations to adapt to the specific impacts anticipated as a consequence of climate change; and (3) the populations of the vulnerable are large. The coastal regions of South Asia and the Ganga Basin fit all three criteria and can be characterised as the chief hotspot areas. Two of the field sites for our pilot projects are located along coasts—those in Tamil Nadu and Gujarat—and three—two in the Nepal Tarai and one in Eastern Uttar Pradesh, India—are located in the Ganga Basin. Table 3.1 identifies the partner organisation which led each study.

In addition to the field-based local partner organisations mentioned in Table 3.1, three non-field-based partners provided support for the study on three policy research themes. They were as follows.

1. Winrock International India (WII) provided support with the policy research theme—the role current environmental management activities play in enabling adaptation to climatic variability and change.
2. Institute for Social and Environmental Transition International (ISET-I), Boulder, USA was involved in providing support at global perspective and generating information as well as on the changing dimensions of vulnerability and access to information systems.
3. Ekgaon Technology (ET), India

supported the study with information on policies, systems and strategies regarding multi-functional early warning and communication mechanisms. It addressed aspects like policy scenarios, evolution, and the roles of state and central government and other stakeholders. ET also reviewed existing communication protocols and guidelines for enabling the communication and sharing of information. The team also held discussions with communication system stakeholders in New Delhi, Chennai, Ahmedabad and Gorakhpur, cities which served as the points of coordination for all the early warning information provided to the project sites.

Basis of selection

All the field sites were chosen for their physical/ ecological, socio-political and economic vulnerabilities. Physical vulnerability includes the threat of storms, cyclones, floods and droughts as well as salinity ingress whereas socio-political vulnerability includes factors like heterogeneity, caste, gender, age, conflict, and religion. Economic vulnerability, for its part includes poverty, livelihood changes, and migration. The nature of the local hazards experienced was a key consideration in making the selection. In terms of the latter those places subjected to the greatest intensity, frequency and impacts of natural disasters were chosen. In selecting the sites in the Bagmati Basin in Nepal, for example, we considered the nature of the Bagmati and the Lal Bakaiya rivers. Both are prone to monsoon flooding though the latter is more flashy and capricious in the upper reaches. The villages selected in Eastern Uttar Pradesh have grown increasingly prone to floods and droughts, while the villages in coastal Tamil Nadu and Gujarat are vulnerable to climatic hazards such as floods, cyclones and droughts as well as to high levels of salinity ingress. For example, the fourth IPCC (2007) report has acknowledged that the global scale of the problem as well as its magnitude: "sea level rise might range from 1/3 meters at current rates up to perhaps 3-4 meters over the next century. It is important to note that even small rises in sea level could increase coastal salinity problems". In addition, since the selected villages are located where rivers meet the sea, there is inundation of upstream areas when high tides are coupled with inland floods and drainage is constrained. Other disasters the coastal regions face are cyclones and tsunami while earthquake hazards are common to all four sites. A purely practical factor which guided selection was the presence of a local partner

TABLE 3.1:
STUDY REGIONS AND PARTNER ORGANISATIONS

Country	Basin/Coastline	District/State	Villages	Partner Organisation
Nepal	Bagmati/Ganga Rohini/Ganga	Rautahat Nawalparasi	Bhasedwa and Brahmapuri Rampurkhadauna and Devgaon	ISET/NWCF
India	Rohini/Ganga Tamil Nadu	Maharajgunj	Manoharchak, Lakshmipur, Sonatikar, Cuddalore Old Town,Pitchavaram, TS Pettai and Pushpavanam	GEAG MIDS
	Gujarat		Tarasara, Sartanpar and Katpar	UTTHAN

TABLE 3.2:
THE STUDY SITES

Country	Basin	Taluk	District	Villages	Population		
					Male	Female	Total
Nepal	Rohini		Nawalparasi	Rampur Khadauna	2,273	2,116	4,389
				Devgaon	2,819	2,605	5,424
	Bagmati		Rauthaut	Bhasedawa	3,252	3,200	6,254
				Brahmapuri	2,230	2,102	4,332
Gorakhpur India	Rohini		Gorakhpur	Sonatikar	285	240	525
			Maharajganj	Lakshmipur	906	859	1765
				Manoharchak	239	228	467
Tamil Nadu, India	Ecosystem I	Cuddalore	Cuddalore	Cuddalore Old Town	15,200	14,800	30,000
	Ecosystem II	Chidambaram	Cuddalore	Pitchavaram	2,550	2,500	5,050
		Sirkazhi	Nagapattinam	T S Pettai	554	569	1,124
	Ecosystem III	Vedaranyam	Nagapattinam	Pushpavanam	3,150	3,100	6,250
Utthan Gujarat, India			Bhabnagar	Katpar	5,400	5,600	11,000
			Amreli	Sartanpar	7,243	7,192	14,435
				Tarasara	1,853	1,747	3,600

organisation in the village which could oversee implementation of the adaptation pilot project.

A fourth criterion had to do with the likely connection between those field-level issues that were likely to be of more importance and national policies relating to, and the knowledge management of environment, vulnerability and communication. In particular, since all field locations are vulnerable to the rapid onset disasters, including flooding and extreme storm events, early warning systems and the role of ecosystems, including flood plains and mangrove forests, in buffering extreme events are of great concern. In addition, the fact that in all sites the location, nature of residences and workplaces greatly influences the impacts of such rapid-onset events, made it likely that their patterns of vulnerability would also be similar. Furthermore, many of the factors that influence local-level vulnerability, such as access to communication systems, the existing social context and the presence of households in high-risk locations such as flood plains are linked to the very social relationships that limit national policies and knowledge management. In short, while the activities carried out in the field worked together as an integrated project in its own right, they also formed the core constituents of a larger programme linked to policies and knowledge management.

Descriptions of the four field sites

The four locations represent diverse geographies, ecosystems, socio-economies, cultures and political systems. While the Nepal Tarai and Eastern Uttar Pradesh are contiguous and share a similar culture and language, the political contexts of the sites are different. Eastern Uttar Pradesh is a state in stable India while Nawalparasi[1] and Rautahat districts lie in Nepal, a country undergoing radical social and political changes. When the study began in 2006, Nepal was a constitutional monarchy, the only Hindu kingdom in the world; now it is a secular republic. Table 3.2 provides a short overview of our study sites before we describe each in detail.

[1] Nawalparasi District in Nepal has mountains valleys, Chure range and Tarai. Our study focused on the Tarai part of the basin.

Nepal Tarai

Both Nawalparasi and Rautahat districts are susceptible to flooding, which creates three key problems: inundation, bank-cutting and sand deposition. Broadly speaking, the populations in both basins are at the social and economic margins. The flood problems contribute to vulnerability of the population in the both locations. Of the total 135 village development committees (VDCs), four VDCs, two in the Rohini and two in the Bagmati river basins were selected: Rampurkhadauna and Devgaon and Bhasedwa and Brahmapuri respectively.[2] The study VDCs of Bhasedwa and Brahmapuri are located in the *doab* (between-river space) of the Bagmati and the Lal Bakaiya. The four villages selected are particularly disadvantaged.[3] Monsoon rainfall is the primary cause of flooding in all four VDCs. In Rampurkhadauna, drainage congestion exacerbates the adverse effects while in Brahmapuri, embankments built in the state of Bihar along the southern border of Nepal and also along the lower reaches of the Bagmati River in Nepal prevent floodwaters from draining naturally and contributes to water-logging for extended periods.

Bagmati River Basin: The Bagmati River Basin in central Nepal covers a catchment area of about 3,750 km^2 which includes parts of eight districts: Kathmandu, Lalitpur, Bhaktapur, Makwanpur, Kabhre, Sindhuli, Rautahat, and Sarlahi. The Bagmati River begins from north of Kathmandu, at Shivapuri, and drains out of Nepal into the Indian state of Bihar, where it joins the Koshi River near Badla Ghat in Khagaria District before joining the Ganga River in Bihar. The Nakkhu, Kulekhani, Kokhajor, Marin, Lal Bakaiya and Chandi rivers are its major tributaries. Other rivers that drain the Chure hills, the Lakhandehi, Ratu, Jhanj, Kalinjor and Fuljor, flow into the Bagmati River only in Bihar, so their catchments are not included as part of the Bagmati River in Nepal.

The Lal Bakaiya River originates in a small valley of Makwanpur District, from where it flows to Rautahat District before joining the Bagmati in Bihar a few kilometers downstream of the Nepal-India border. In Makwanpur District, it is called the Bakaiya, but when it reaches the Tarai, it takes on a reddish tinge from the soil of the Chure range and is known as Lal (Red) 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 because of its flashy nature. A high flood in the river last for only about four to five hours but causes great damage as it carries a huge sediment load. Bank-cutting and the deposition of sand on flood plains are common.

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 rivers. Both rivers are embanked in India and the structures extend into Nepali territory. The Bairgaina Block of Bihar is situated between the Bagmati and Lal Bakaiya rivers and borders Rautahat District of Nepal to the south. The block is surrounded by embankments known locally as a 'garland embankment'.

Rohini River Basin: The Rohini is a tributary of the West Rapti River, which itself is a tributary of

2 The Tarai part of Nawalparasi District has 39 VDCs and one municipality. Rautahat District has 96 VDC and one municipality.

3 Our adaptive study project *Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for Responding to Floods and Droughts in South Asia* (Moench and Dixit, 2004) used empirical evidence collected in the eight VDCs of these two districts.

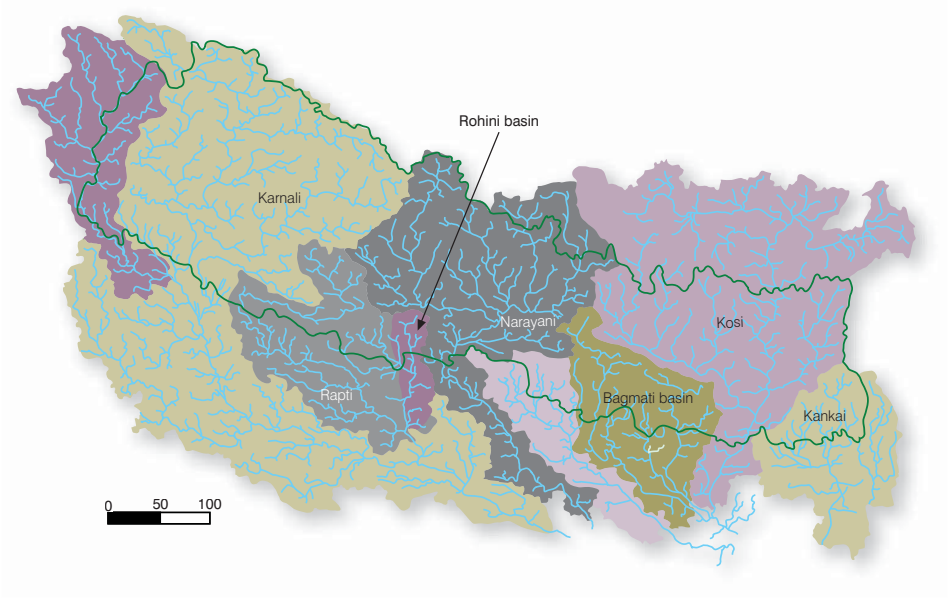
the Gandak River, joining it in north of Gorakhapur. Originating in the Chure hills, the river crosses the Indian border after draining parts of Nepal's Rupandehi and Nawalparasi districts. Most of the area it drains is within the 1,960 km^2 area of Nawalparasi, which has four distinct geographical zones: the hills, the inner Tarai, the Chure and the Tarai. The Parasi plain is a continuation of the north Gangetic land system. The catchment area of the Rohini lies between the municipality of Butwal in 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. 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 small tributaries (*nala, kholsa, khahare* (ephemeral stream)*, khola (small streams)* and rivers*)* flow into the main stem as it flows south. As they flow, the tributaries change course, split into distributaries and capture neighbouring streams. The tributaries of the Rohini in Nepal are the Jharahi, the Dhanewa, the Bhumahi, the Bhaluhi and the Somnath. Each begin as a *khahare* on the southern slope of the Chure and later joins the Rohini before that river enters Uttar Pradesh at Mishrauli, Nautanawa Block.

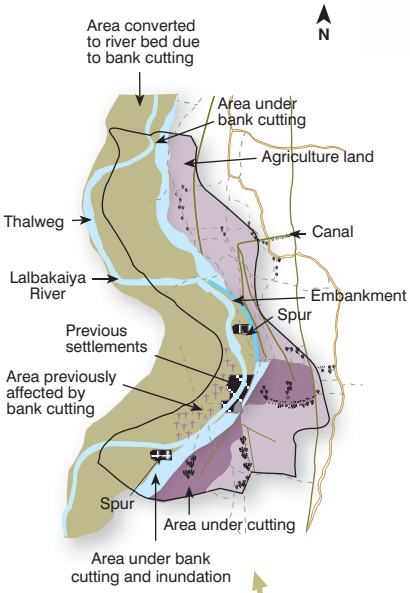
Of the Rohini's total length of 122 km, 43 km lies in the *bhabar* region and upper Tarai of Nepal while the rest is in India. The Rohini River has a total catchment area of 2,686 km^2, just 794 km^2 (30 %) of which lies in Nepal. However, this 30% contributes more run off than that generated within the much larger lower catchment in Uttar Pradesh, 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 is in Rupandehi. The Rohini River system and its tributaries such as Jharahi and Dhanewa drain almost all of the Parasi Tarai. Some of the tributaries flow into Uttar Pradesh where the rivers have different names. After they conjoin the Dhanewa and Jharahi becomes 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.

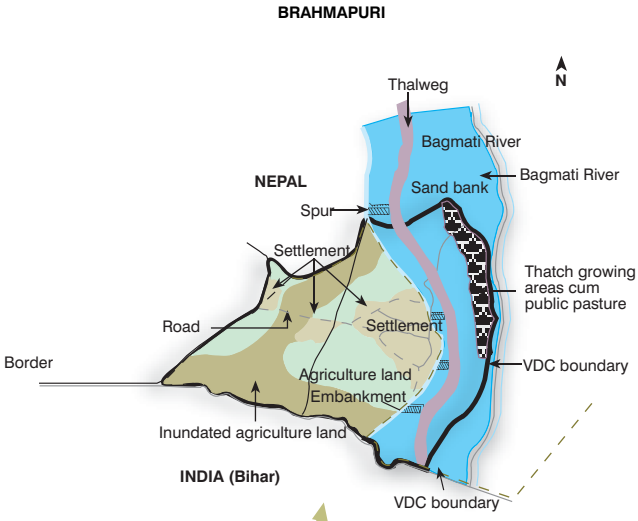
The slopes of the Rohini River and its tributaries change within a few kilometres of their origin in the Chure range. Because the gradient is low, they have a tendency to flow in braided form and deposit sediment. Even though the slope is greater in higher reaches, sediment deposition is also greater 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, continues to be carried further downstream. The lower reaches of the Rohini receive sediment from the upstream sections as well as from the erosion of the river 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. Suspended loads, however, are transferred still further downstream. The effects of flooding in the lowest reaches are severe because the stream gradient is less than 0.1. The study sites are shown in Figure 3.1 and the four VDCs are described next page.

Bhasedhwa: Bhasedhwa VDC lies in Rautahat District in central Nepal 33 km northwest of the district headquarters, Gaur, and about 20 km southwest of Chandranighapur on the East-West Highway. The village is situated in what was once called Nepal's *char kose jhadi* (four mile forests) which has gradually been cut in the last fifty years. About 6,254 people live in

FIGURE 3.1:
STUDY SITES IN THE BAGMATI AND ROHINI RIVER BASINS

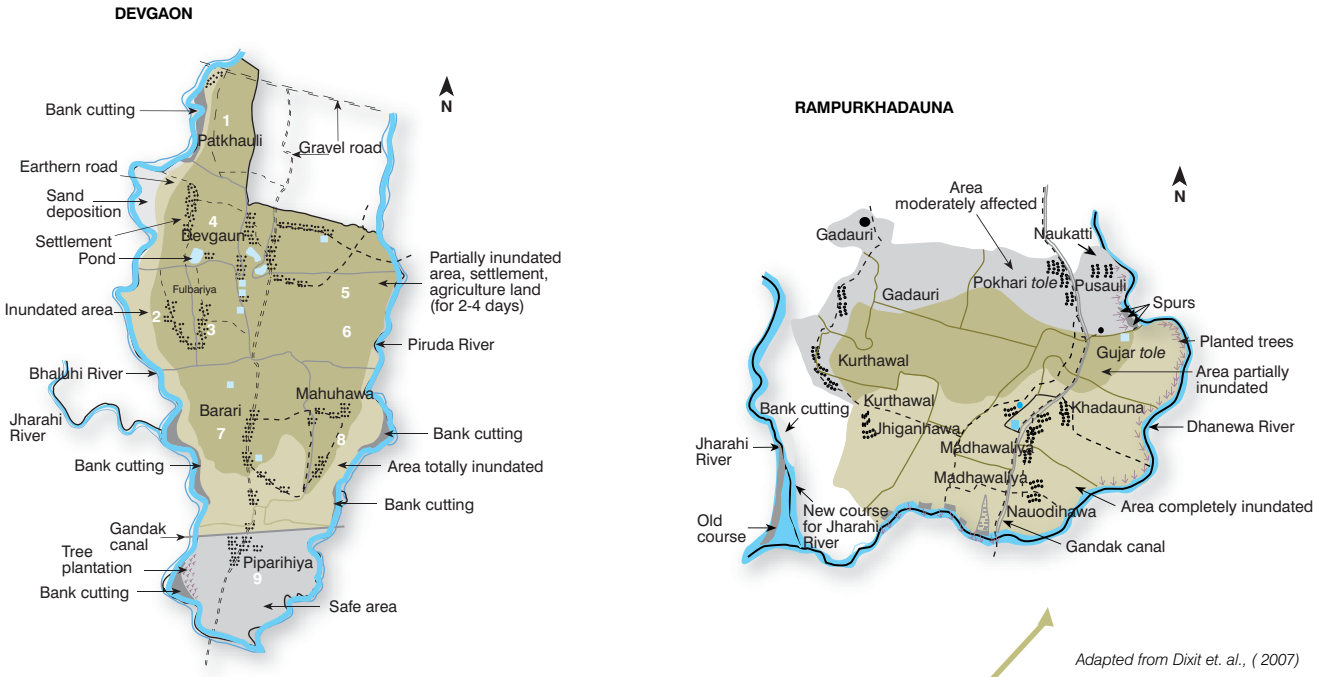




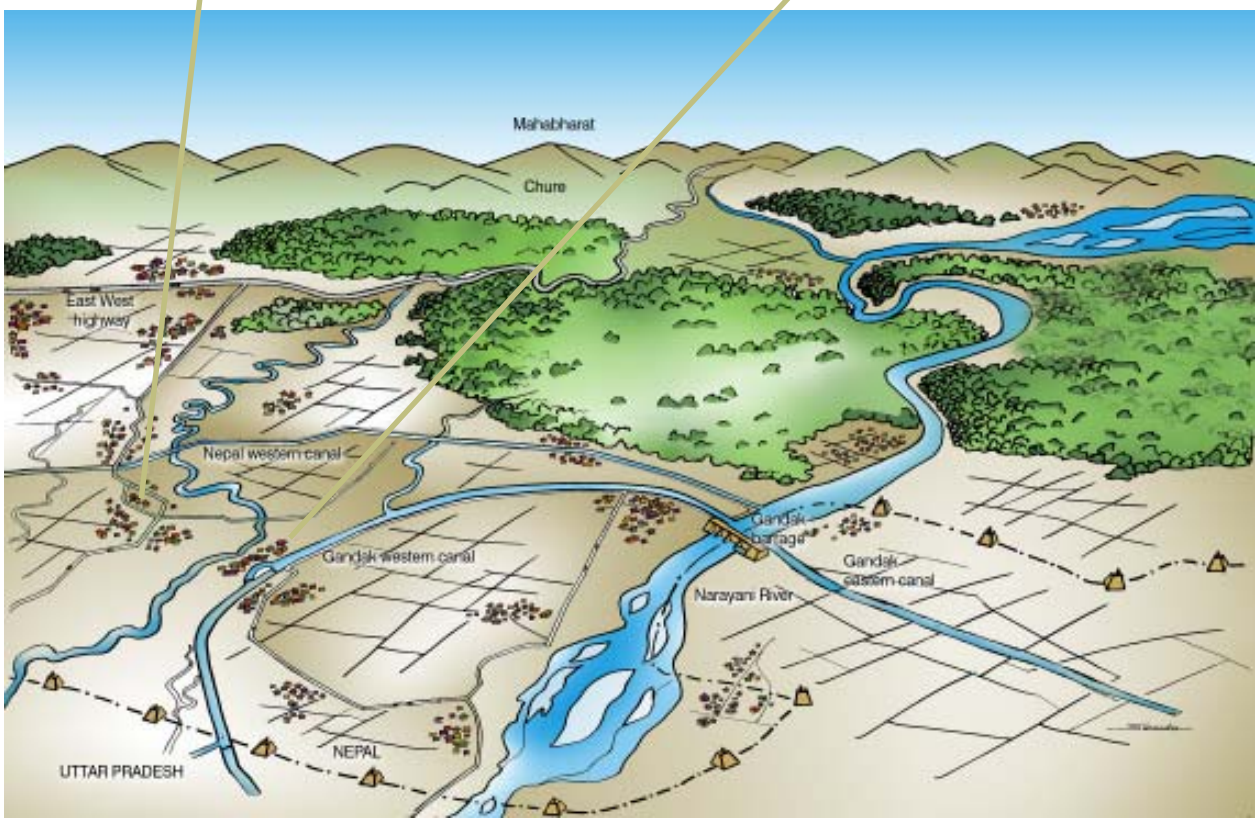


Transect of lower Bagmati basin

Adapted from Dixit et. al., (2003)



Adapted from Dixit et. al., (2007)



Transect of upper Rohini basin

935 households. All live in extreme poverty, a condition exacerbate by the regular monsoon flooding of the Lal Bakaiya River, the "Sorrow of Bhasedhwa." In the decades of 1959-1968, 1969-1978 and 1979-1988 respectively, 20, 30 and 200 *bigha* of forest was cleared in Bhasedhwa. In its 40 year history, about 600 households have been displaced. Regular flooding has resulted in a substantial decrease in the fertility of its agricultural lands such that today only about 38 percent of the population produces enough food for more than six months. The literacy rate stands at just 36% and infrastructure, including health services, safe drinking water systems and sanitation is minimal.

Bramhapuri: Bramhapuri VDC lies in Rautahat District five km southeast of Gaur and about 47 km south of Chandranighapur. Its current population of about 4,332 lives in 627 households. Floods in the Bagmati River have been affecting the village for decades. Every year households get displaced from the village and in last 20 years about 100 households have been displaced. Of 334 *bigha* of productive land only 100 *bigha* are still productive. During the 1993 floods alone, 100 households were displaced and 40 *bigha* of cultivated land was damaged. When a section of Bagmati canal breached in 1999, another 100 households were displaced and crops growing on 100 *bigha* were destroyed. People believe that the extent of flood devastation is increasing and they are losing more and more cultivated land, crops, livestock and property each year. Agricultural productivity has dropped significantly, with only 36% of households producing enough food for more than six months. Only about 41% are literate and the VDC is one of the poorest in the district.

Devgaun: Devgaun VDC lies in Nawalparasi District eight km southeast of the district headquarters in Ram Gram Municipality and is connected to it by a dirt road. It is about one km from Sunawal Bazaar on the East-West Highway. The population of 5,424 lives in 845 households and own 993 *bigha* of cultivated land. The regular flooding of the Piruda and Bhaluhi rivers has decreased both the amount and productivity of agricultural land in the last 30 years. Today crops such as *rahar* and *musuro* (types of lentils), peas, and gram can no longer be grown. Bank-cutting, inundation, and sand deposition have made farming difficult and the irrigation canal which serves about 500 *bigha* of agricultural land does not provide a reliable supply of water. As a result of these factors, only 57% of the population produces enough food for more than six months. Poor access to information about policies, relief and climate issues contribute most to the socio-economic vulnerability of villagers. Only about 49% are literate.

Rampurkhadauna: Also in Nawalparasi District, this VDC borders Uttar Pradesh to the south and is located 18 km southeast of the headquarters and about 27 km southeast of Sunawal Bazaar. The village has a population of 4,389 (up from 2000 in 1950) and a total of 659 households. The Dhanewa River flows from the northeast and the Jharahi River flows from the southwest to form its boundaries. In 1950 the village cultivated 800 *bigha* of land; our May 2007 showed that the area has doubled to 1,190. Agricultural productivity has declined in the last 30 years and today about 61% produce enough food for more than six months. Dhanewa and the Jharahi rivers first began to flood in 1961 and have cause severe damage in ward numbers 7, 8 and 9. Before 1992, there were no motorable roads in the village, but today there is a gravel road to the headquarters and local roads are paved with bricks. After 1993, Oxfam helped to install small drains and raise the plinths of some houses. Adult literacy is 52%.

Eastern Uttar Pradesh

Eastern Uttar Pradesh is a flood-prone region on the Indo-Gangetic plain. Situated in north of the Ganga River, the region is commonly known as the trans-saryu plain. The flood-affected areas consist of the low-lying district of Maharajganj, whose socio-economic and human development indices are lower than those of other Indian states. 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 progress in education, and destroy rural infrastructure. The effects of flooding are exacerbated by factors like poverty, poor health services, malnutrition, illiteracy, lack of food and livelihood security, extensive out-migration and widespread ecological degradation. Eastern Uttar Pradesh is a riparian land system formed by the Gandak, West Rapti and Rohini river systems. The Gandak is a snow-fed river that originates in the Nepal Himalaya. The West Rapti also originates in Nepal, but is a rain- and spring-fed river which originates in the Mahabharat range. It meets the Gandak near the town of Gorakhpur, Eastern Uttar Pradesh. The Rohini River system also originates in Nepal. It is composed of three main 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.

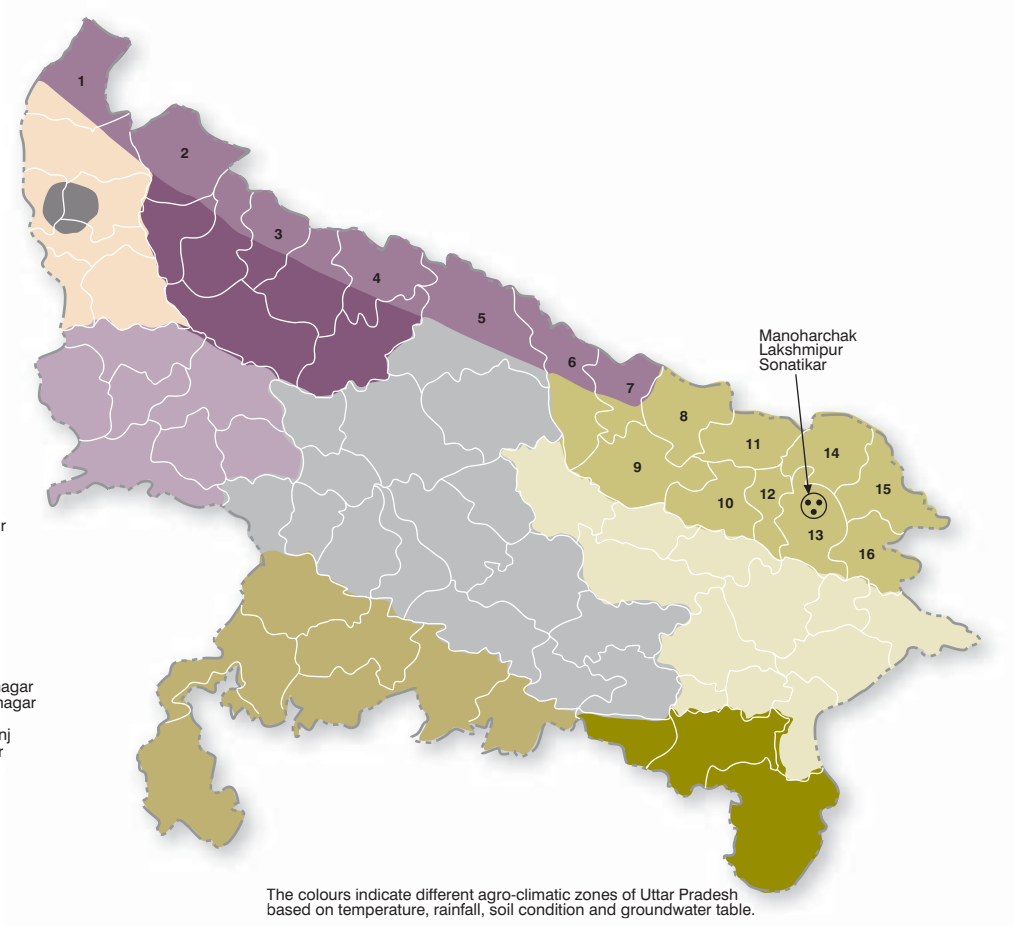
Although the Rohini River system is used extensively and causes large-scale flood damage, it does not appear on the radar screen of the governments of either Nepal or India. Field sites were selected within the Rohini Basin because it has faced major floods in the past. Records show floods in the year of 1904, each year between 1952 and 1957, in 1960, and then again in the years of 1962, 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 in each case villagers sought shelter on nearby embankments for many days. The receding floodwaters deposited sand on agricultural land, rendering them 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 there was the result of the overflowing of rivers in the lower parts of the northern Ganga plains.

The project areas are located in the district of Maharajgunj. Communities residing here experience floods that last longer than they do in Nepal.[4] People earn their livelihood mainly through agriculture, fishing and dairy farming. The stress floods place on these livelihoods has resulted in a high rate of out-migrations.

Manoharchak: Manoharchak, a small village of just 104 households, is situated on the banks of the Rohini River 40 km from Gorakhpur, the district headquarter. Agriculture, the main source of income for the residents, is seriously affected by the flooding associated with the embankment outside the village. Built along the Rohini 35 years ago, the embankment does check regular floods but it has also constrained flow and thereby increased the water-logging of agricultural fields. As is typical in the region, most farmers own less than one acre of land and the village itself lacks basic water supply, sanitation and health services. Consequently, the rate of out-migration is high.

[4] The duration of inundation depends on issue such as the extent of disturbance to natural drainage. In normal natural condition, a flood of certain magnitude inundating Nepal Tarai for a day would inundate land for about 3 days in the lower Tarai because of low very slopes. But the extent of inundation is also a result of constrained drainage.

FIGURE 3.2:
STUDY SITES IN EASTERN UTTAR PRADESH



Lakshmipur: Lakshmipur, a village of 199 households, is situated on the banks of the Rohini River 45 km from Gorakhpur. This village, too, is regularly flooded. Most of the agricultural land in the village is surrounded by embankments and, as a result, becomes water-logged when rainfall is heavy. 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. The Maharajgunj Irrigation Department has an office in the village that regularly maintains the embankments.

Sonatikar: Located 45 km from the district headquarters, Sonatikar is situated on the bank of the Rohini River. It is one of the most-flood affected villages in the region though a long embankment stands between the village and the river. The embankment prevents the village of 100 households from being inundated but also prevents rainwater from draining out of the agricultural fields back into the river. As a result, heavy rains leave fields waterlogged for two to three months. Almost half of the villagers have moved to the main road, which, according to them, is safer during floods because it is more elevated than the surrounding land.

In all three villages, the majority of the farmers are "marginal farmers" who own less than one acre of land. Landless families depend on the income they earn by doing seasonal agricultural labour.

Coastal Tamil Nadu

Tamil Nadu's has the second longest coastline of any Indian state—1,061 km. About 29 of its 62 million people live in its 13 coastal districts; for the most part their livelihoods depend on both deep-sea fishing and fishing in its numerous backwaters (interconnected drainage network consisting of, brackish water rivers, lakes and freshwater river inlets), but agriculture is also an important livelihood. Tamil Nadu's coastal wetlands have high hydrological, biological and socio-economical values but they, like wetlands elsewhere in India, has been severely degraded. They are polluted by industrial wastes, groundwater is over-extracted, sea water ingress and sea erosion

are in advanced stages, marine resources are over-exploited, and coral reefs and mangroves are in poor shape. The state's coastal area is regularly exposed to multiple hazards—coastal floods, tsunamis, storm surges, cyclones and strong winds. One such hazard was the tsunami of December 2004, which affected about one million people living in 376 coastal hamlets and killed about 10,000. Most of the damage occurred in Cuddalore and Nagappattinam districts. The population is made vulnerable by the threat of sea-level rise, changes in the coastal ecosystem, land-use patterns that are socio-economically and environmentally degrading and saltwater intrusion into coastal aquifers. People report that the climate has changed. In the past, the *aadi* (mid-June) rain fell timely, helping the broadcast method of sowing, but for the last 10 years, rainfall has been erratic or lacking altogether. In addition, the northeast monsoon has brought excessive rainfall in just few days, resulting in the flooding of the land.

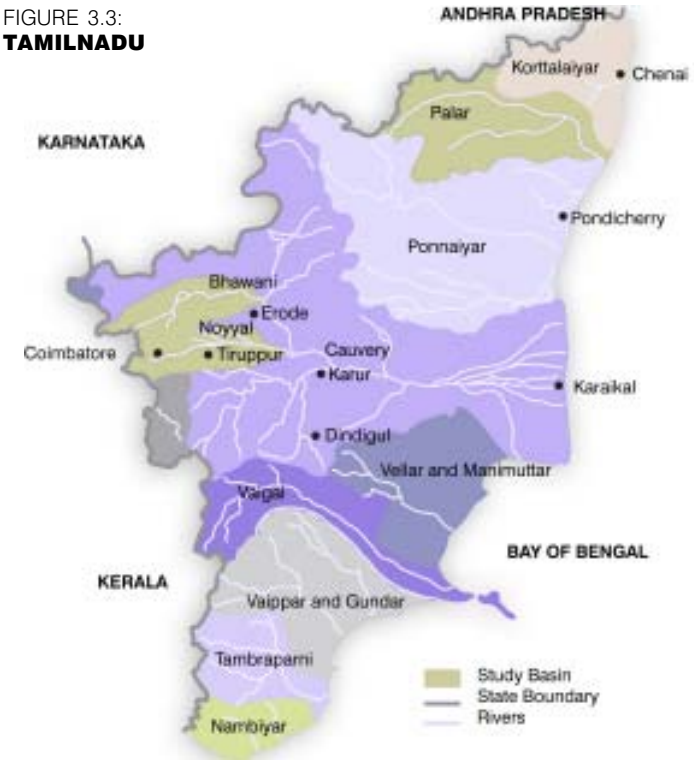
Three of Tamil Nadu's ecosystems were selected for study using two criteria: access to livelihoods and the availability of coastal wetlands. In ecosystem I, the only means of livelihood is fishing, whereas both fishing and agriculture are important in ecosystem II and ecosystem III (as dominated by dry-land agriculture and backwater fishing).

Ecosystem I: Ecosystem I, which comprises Cuddalore Old Town, is threatened by sea-level rise, coastal storms and cyclones, and increasing pollution. Around 30 industries producing goods such as pesticides, pharmaceuticals, dyes and paints discharge their effluent into the sea and have contaminated both it and the groundwater on which the villagers depend. Levels of air have also escalated since industrial operations began in 1980. The chemical industries release volatile organic compounds (VOCs) which have had a negative impact on health, increasing the incidence of diseases like chronic respiratory problems, throat infections, constant headaches, tuberculosis, dermatological problems, gastroenteritis, tooth decay, gastrointestinal diseases and even miscarriages.

Most of the 30,000 people in Cuddalore Old Town earn a living by marine fishing supplemented by fishing in the Uppanar River. The ecosystem is threatened not only by sea-level rise, coastal storms and cyclones, but also by increasing pollution. Industrial growth has made it one of the most polluted areas in the region as about 30 industries producing pesticides, pharmaceuticals, dyes and paints discharge effluents without treating them, contaminating the sea, the backwaters and even the groundwater on which the villagers depend. The residents see industrial pollution as a slowly unfolding disaster and report that the fish catch has gone down by 80% since the industries opened few years ago. Some species, such as *sudhumbu, navarai, sura, yeral,* and *kanavai*, have disappeared altogether. Until two decades ago, shrimp caught in the backwaters was exported; today, there are no shrimp. The fish that are caught cannot be sold for human consumption because they smell of chemicals. Instead, it is dried and sold to manufacturers of poultry feed. Over 100,000 people who once depended on river fishing, small-scale salt production and small-scale farming have lost their livelihoods because of the wanton release of untreated industrial effluents. Those who can no longer earn a livelihood through fishing have become daily wage labourers. Since the labour market is not guaranteed, they face uncertain future.

There is little opportunity for diversifying livelihood in Cuddalore Old Town. Children who

FIGURE 3.3:
TAMILNADU



drop out of school, as young as 14, usually do so to help their families eke out a meagre living from fishing. Only a small percentage of the total population of the old town—about 10%—have taken on alternative work as small vendors, construction workers, road builders and factory workers. The caste of traditional fisher-folk, the Parvathataja Kulam, is classified by the government as one of India's most backward castes. Of the 545 (of 547) Parvathataja Kulam households in Sonankuppam area of Cuddalore Old Town, 91% are fisherman, 7% are fish traders, and only the remaining 2% are engaged in non-fishing, service sectors like vending, transport, and government service.

Because the physical environment increasingly does not sustain traditional fishing livelihoods and because the population has been unable to move into other income-generating sectors, they are extremely vulnerable to disaster and, by implication, the stresses associated with climate changes. In the other two ecosystems heterogeneity in caste do exists but people pursue diversified income sources like fishing and agriculture.

Ecosystem II: Ecosystem II comprises the villages of TS Pettai, a coastal fishing hamlet in Pitchavaram Revenue Village, Chidambaram Taluk, Cuddalore District. Out of the total 280 households, 200 (65%) are engaged in fishing, while the rest work in agriculture or construction, or as retail grocers, mechanics, electricians and other service-providers. About 30% of the population is classified as scheduled castes, most of whom are daily wage earners. The village is one km from the coast, behind the Pitchavaram mangrove forest at the tail-end of Cauvery Basin, and has a five km long backwater channel flowing through it. Agriculture is the mainstay in the village, twenty years ago it used to be possible to use water from the Cauvery River to double-crop, but now it is a single-crop area. The major crops planted on its 350 acres of agricultural land are groundnut (85%) and paddy (15%). Ten years ago, 20 acres were converted into prawn ponds because the fields were often inundated and the land had turned saline and unfit for agriculture. The village fishermen own these prawn farms.

There are few infrastructures available in TS Pettai and those include a community hall, a library, health center run by the Red Cross Society, a primary agricultural coop society, a mother and child care centre, cyclone shelter, three primary schools, three day care centres, and four overhead drinking water tanks with a combined capacity of 29,000 litres. These health facilities are not able to meet major cases for which villagers go to Chidambaram for treatment.

Flooding from the sea has occurred frequently in the past 10 years. During each month's high tide

FIGURE 3.4:
STUDY SITES IN TAMIL NADU

period, seawater floods rivers and adjacent agricultural lands as well as brackish backwaters. In the last 30 years the village has witnessed eight severe cyclones, more than 10 moderate ones, and at least 15 seasons of heavy flooding.

Most of ecosystem II lies within the deltaic region of the Cauvery River. Besides coastal flooding, high flows in the Cauvery River and its numerous tributaries cause inundation; alterations in the natural flooding cycle of the river caused by upstream interventions have exacerbated the problem. The use and allocation of the Cauvery water is an issue of heated dispute between the states of Tamil Nadu and Karnataka. Since the late 1970s, the river has acquired a seasonal character (it was once perennial), remaining dry for over six months of the year. This change in the river's hydrology has increased the incidence of flooding from the sea and increased land and groundwater salinity in consequence. As a result, there is a scarcity of safe drinking water and Pitchavaram's 3,500-acres of mangrove forest are under threat.

The villagers of TS Pettai, Pitchavaram and Vanagiri earn their livelihoods form both fishing and agriculture. This region, most of which situated within the deltaic region of the Cauvery River, is subject to coastal flooding and inundation caused by high flows in the Cauvery River and its numerous backwater tributaries themselves triggered by upstream interventions.[5] Since the late 1970s, the river acquired a seasonal character (it was once perennial), remaining dry for over six months of

5 The use and allocation of water from the Cauvery is an issue of dispute between the states of Tamil Nadu and Karnataka. This dispute also has a role in defining the nature of stress in the coastal regions.

the year. This change in the river's hydrology has increased the occurrence of flooding from the sea and, in consequence, has so elevated the salinisation of the land and of groundwater that agricultural productivity has declined, drinking water has become scarce, and the 3,500-acre Pitchavaram mangrove forest is under threat.

In TS Pettai, 43%, 41%, and 16% of the people are fisher-folk, farmers and landless agricultural labourers respectively. All of the farmers are also engage in non-agricultural activities and all of the fisher-folk also earn through non-fishing activities such as construction. Because of this diversification in livelihood, villagers are fairly resilient in the face of disaster, but it has left them with a shortage of agricultural labourers. For Pitchavaram, this has proved to be a handicap to building resilience. Its population of 5000 is divided into six caste- and livelihood-based hamlets, with fisher-folk living on the coast and farmers inland. Its heterogeneity has been dividing rather than a unifying force, with the politics of inclusion and exclusion fuelling animosity among groups. Also making Pitchavaram vulnerable is the fact that, in comparison to TS Pettai, Pitchavaram has less livelihood diversification: 60% are farmers, 15% landless agricultural labourers, 15% construction and other non-farm workers, and 10% are variously small businessmen, fishermen and traders. Unfortunately, with three-quarters of the agricultural land turned saline due to seawater ingress, farmers are finding themselves increasingly vulnerable.

Migration, both seasonal and long-term, is another source of income diversification though it is not very common in these villages. About 20 people from TS Pettai work in Singapore, Saudi Arabia or Dubai, indicating some diversification of livelihood, while from Pitchavaram 120 men migrate to Kerala for agricultural work in season and 50 families have settled in Ahmadabad to work in an asbestos cement factory or as construction workers or traders.

Ecosystem III: Pushpavanam is the village we studied in ecosystem III, a region surrounded by the brackish Uppanaru River on three sides and bordered on the east by the Bay of Bengal. The 6250 villagers comprise 1779 households, 15% of whom belongs to scheduled castes, 60% of whom fall below the poverty line, and 50% of whom are landless. Agriculture is the main livelihood, though about 10% depend upon marine fishing. Groundwater is somewhat saline and no other source of irrigation is available. In summer months, the village experiences shortages of drinking water. People also face the threat of inundation due to seawater flooding.

Most of the population of the village of Pushpavanam relies on agriculture for its livelihood but a small segment engages in marine fishing. The village is surrounded by backwaters on three sides, and the Bay of Bengal borders it to the east. Both droughts and flood have affected the village. Excessive heat and drought conditions have brought famine, while cyclonic rainfall has brought floods and destroyed huts. With each cyclone, seawater ingress has made the land and groundwater more saline. In addition, seawater flooding was a constant threat. Although the village lies within the Cauvery delta, farmers cannot exploit gravity-flow irrigation from the river because the village is on higher ground. Right after the monsoon, the water table is about 10 feet underground, but in the summer months, the level drops and salinity increases, causing a dangerous scarcity of drinking water and making it very difficult to irrigate. Most crops are rain-fed and paddy is cultivated by directly sowing seeds rather than by transplanting seedlings.

Coastal Gujarat

Gujarat has the longest coastline of any Indian state—1,600 km of the total 7,500 km. The coastline is rich in ecological resources and biodiversity. It is endowed with a very wide range of coastal ecosystems, including mangroves, coral reefs, sea grasses, salt marshes, sand dunes, estuaries, and lagoons, all of which play a vital role in Gujarat's economy. Coastal Gujarat is a multi-hazard zone, where floods, droughts, cyclones, salinity ingress and earthquakes are common. Salinity ingress affects nearly 30% of the total land area of the state, or 9000 km^2, and is increasing at the rate of 1.5 km per year; both the soil and freshwater aquifers have grown more saline. The situation is so dire that coastal villages like Saurashtra and Kutch can no longer pursue land-based livelihoods along the coast. Sea-level rise has disrupted wetlands, caused flooding and erosion, and accelerated the process of saltwater intrusion, a process which harms local flora and fauna and reduces ecosystem productivity. Cyclonic conditions often take lives and destroy property on a large scale. In 1998, for example, thousands perished in the cyclone that hit the Kutch coast. In addition, many coastal areas of Gujarat were affected by the major earthquake of 26 January, 2001.

In addition, the increasingly erratic nature of the monsoon is an emerging problem, one evident in the Rajula coastal area of Saurashtra for the past four years. Not only rainfall has become intense, with the area witnessing heavy downpours, but the number of rainy days has decreased. Consequently, local flash floods, which invariably affect livelihoods, have become more frequent. This changing nature of hazards adds to the enormous scale of devastation caused by human activities, primarily the burning of fossil fuels and the associated trend of global warming, which has put unprecedented pressure on coastal environments.

FIGURE 3.5:
GUJARAT STATE CYCLONE ZONE

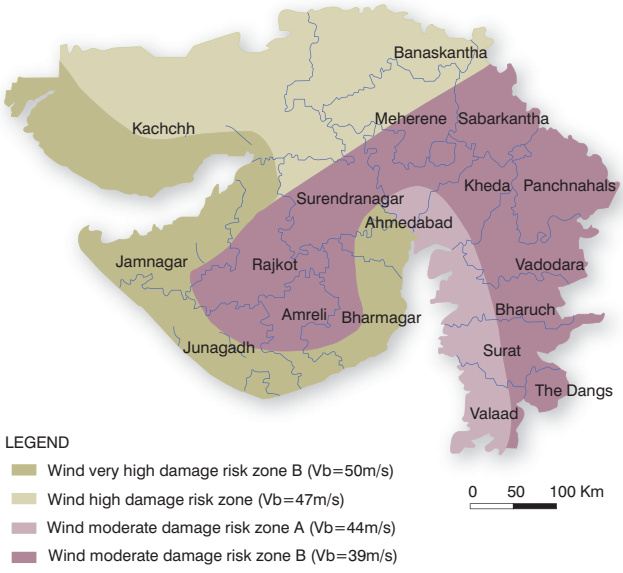


FIGURE 3.6:
STUDY VILLAGES IN COASTAL GUJARAT

Other forms of ecological degradation also adversely affect coastal-marine ecologies and fisheries. They include pollution caused by the widespread dumping of untreated industrial effluents in rivers and in the sea. The construction of private jetties has had a negative impact on mangrove forests, as had the use of saline coastal land for drying the salt water for producing salt.

The net outcome of all of these ecological stresses is that the traditional livelihood patterns of diverse communities living along the coastlines are in jeopardy, leaving them more marginalised and vulnerable than ever before.

The study selected Tarsara, Katpar and Sartanpar along coastal of Saurashtra. In the following section we provide a issues specific to the villages followed by general description of the three villages.

Tarasara: Situated on the banks of the Shetrunji River and the smaller Keri River, and in vicinity of the Arabian Sea, this ancient port village is susceptible to both cyclones and floods. The effects of monsoon floods are made more severe because of the ingress of saline water during high tides. In fact, almost 85% of the land is saline and only rain-fed agriculture is still in practice. The village has a population of 3600.

Katpar: Katpar is a prosperous port located in a low-lying area near the Malan estuary in Bhavnagar District of coastal Gujarat. It is divided into three main areas: main Katpar, the Katpar Bandar and the lighthouse area. Utthan's August 2006 PRA counted 11,000 people in 1,500 households, 5,600 of whom are women and 5,400 are men. The same survey found that the literacy for men and women varied: 10% women are literate while the rate for men is 20%. Of the total households 1,447 are of the Koli caste and 30 of the Bharward (shepherd); Muslims and Devipujak make up the rest. About 76% of the population has no land and 27% are directly impacted by floods, which are caused in part by a tidal regulator built to prevent seawater from flowing inland. Cyclones affect about 45% of the population in Katpar and 75% in Bandar as well as those people who live in *kuccha* (huts) houses in the lighthouse area. Salinity of both soil and groundwater is a problem and since there is no irrigation facility all agriculture is rain-fed.

Sartanpar: This ancient village port is also situated on the banks of the Shetrunji and is contiguous to the Arabian Sea, so it, too, is prone to both cyclones and floods, which are made more severe by the ingress of saline water. Flooding constrains both household activities and employment. According to Utthan's 2006 PRA, the total population of the village is 14,435, with 7243 males and 7192 females. The shipping industry is in decline and neither milk production nor marine fishing is as productive as it was once. Nearly 11,000 people migrate for eight months a year in search of better livelihood options.

In the village of Tarasara, 66% (350 households) of the total 530 households are affected by normal floods and another 24% (126 households) by intense floods (Utthan, 2006). Since the residential area is protected by a 500-meter earthen bund running parallel to Keri River, the impact of floods is greater on the 200 acres of agricultural land which lie within the catchment of the Shatrunji River in which nearly 35% of households depend (Utthan, 2006). Most of the flooding in the village is caused by water overflowing the Shatrunji dam and by the opening of its gates. In the 2005 floods, crops were damaged and top soil was washed away, affecting long-term productivity. In the village of Sartanpur, 21% (477 households) of the total 2238 households are affected by floods, which

also wash over the road which connects the village with Taluka Talaja for a week or two, making it impossible for daily wage labourers to commute to work.

Seawater intrusion caused by excessive withdrawal of groundwater in the coastal areas has exacerbated the problem of coastal salinity. In the village of Katpar, all agricultural land is saline (PRA, 2006), while in both Tarsara and Sartanpar approximately 85% of agricultural land is saline. In consequence, villagers rely on migration as the main source of livelihood.

The most devastating cyclone that has hit the region struck in 1982; the fishermen who lost around 80 boats are still struggling to restore and stabilise their livelihoods. Since 1982, all three coastal villages have seen a cyclone every two years but never as intense as that one. Over the past three or four years, 78% of the population of Tarasara village has been directly affected by cyclones. In Katpar, where residents live shows how severely cyclones impact them: in Katpar main, 45% are affected, but in the Bandar and lighthouse areas, nearly 75% are vulnerable as they live in *kuccha* houses. The impact of cyclones on Sartanpar is severe as nearly 82% of the households (1500) are made of mud and have thatched roofs. When wind speed exceeds 70 km/hr, the impacts of cyclones are intense for all, even if they are relatively less vulnerable.

Villagers have diversified their livelihoods by turning away from agriculture as the primary source of income to migration (local, seasonal and long-term) and other off-farm activities. Since salinity ingress has degraded grazing land, the Bharward, a traditional cattle-herding caste, and the Kohli, who adopted livestock rearing in an attempt to diversify, have now been engaging in daily wage labour. In fact, nearly 80% of the population of Sartanpar is engaged in seasonal labour (both farm- and non-farm based) (PRA, Utthan, 2006). For nearly eight months every year they migrate to districts like Junagarh, Rajkot, and Amreli to work mostly as farm labourers or in the diamond industry. The elderly and primary school-going children are left behind. These migrants usually return only for four months (July to October) in order to conduct marriage and other religious and social ceremonies. Another reason for their return is that no agricultural work is available during this period. Floods in July and August can make it difficult for them to return as villages are cut off.

With this description of the study sites, we can now discuss the process by which the project (with, of course, the villagers themselves) identified activities for piloting. The options were identified using a combination of shared learning dialogues; vulnerability analysis and cost benefit analysis methods.

4

PROCESSES OF INTERVENTIONS

Identification of piloting activities needs to build on an eterative learning process.

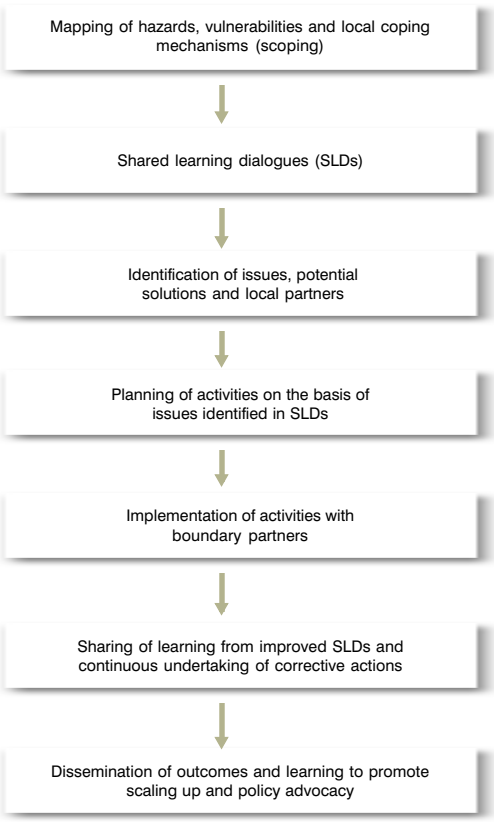
The study planned, designed and implemented a number of pilot activities whose selection was influenced by the results of research conducted by the Adaptive Strategies Project (See Moench and Dixit, 2004). These activities were undertaken only after the detailed collaborative preparatory work needed to design pilot projects was completed. Field activities were implemented only as part of a detailed process that involved working with local communities and organisations in order to identify risk factors and develop packages of support tailored for the specific area in question. The focal points of our support activities were three: (1) physical and communication infrastructures that are themselves adapted to extreme events and can thereby enable livelihood adaptation; (2) strong social infrastructures, such as self-help groups, insurance and access to markets, that increase or develop livelihood resilience and adaptive capacity; and 3) improved environmental management practices.

The methods and approaches of the study were discussed extensively among the study partners throughout the study period. Figure 4.1 lists the methods and approaches undertaken while Table 1 in annex shows the details of the coordination meetings held.

Scoping, methods and approaches

We conducted an intensive village-level study by implementing a series of participatory exercises which used standard research tools such as

FIGURE 4.1:
METHODS AND APPROACHES



participatory rural appraisal (PRA), social and resource mapping, timelines, focused discussions with women's and other groups, individual interviews, and transect walks. At some sites, video clips were also used. In addition, we gathered secondary data and information from a variety of sources, including national disaster resource networks, disaster management authorities, national plans, censuses, and other studies and reports available from the national governments of Nepal and India as well as from the states of Tamil Nadu, Gujarat and Uttar Pradesh. Collectively, these resources clearly showed patterns of vulnerability, the nature of ecosystems and the status of communication—our three main parameters—broadly capturing the context of each of the four selected sites.

Table 4.1 provides details about each of our three main parameters—the variables they comprise and the tools used for assessing them. At each site, the study team conducted an assessment in order to develop an appropriate vulnerability index. That assessment consisted of the following processes:

- **Mapping exposure to climate hazards –** the physical and ecological mapping of different risks and potential hazards.
- **Understanding system sensitivity –** the extent to which a given system will be affected by those risks and potential hazards as determined by differential vulnerabilities, physical and social spaces and structures.
- **Assessing adaptive capacity –** the ability to reorganise and minimise loss at different levels as measured by system resilience and the perceptions and motivations of actors.

Vulnerability Index

Given that there are so many approaches to, definitions and dimensions of vulnerability, the challenge was to decide who is vulnerable – and vulnerable to what. What we needed was an indicator, a means of encapsulating a complex reality into a single, quantifiable or measurable and comparative construct (Vincent, 2004). The HFA itself called for the development of indicators as a key activity in disaster risk reduction (DRR). However, developing a quantitative measure of vulnerability would not be an easy process if it could in fact be developed at all. We needed to consider how and what its limitations would be. To address some of those limitations, we decided to incorporate the other end of the spectrum of existing vulnerability assessments—qualitative, narratives of socio-ecological change and coping and adaptive mechanisms.

Since vulnerability is dynamic, any measure based only on past disasters would have been, at best, indicative. Any good indicator will take into account not only history but also the risk of and susceptibility to future exposure. It should also assess and compare the actual or potential strengths of different response strategies. Using such a complex estimation yields a good indicator of who is vulnerable, and when and how. It also provides points of leverage for addressing vulnerability and building resilience.

It is important to distinguish between impact and vulnerability assessments. Conventional impact assessments which have been used to identify responses to risk have typically focused on the potential downstream 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

TABLE 4.1:
VULNERABILITY ASSESSMENT VARIABLES AND TOOLS

Parameter	Variables	Tools used
Vulnerability	*Livelihood analysis*- Existing livelihood options (local and non-local), household occupations (primary and secondary)	Social map
	Uninformed migration- Trends and patterns of migration, individual household migration, preferred destinations of migration	Seasonality, social map
	Food insecurity- Food-deficient months, season-wise food habits	Seasonality
	Hazards and vulnerable groups- Major hazards, affected areas and households, vulnerable groups	Hazard map
	Level of services and opportunities- Major services and their status, levels of access and satisfaction	Map of services and opportunities
	Physical Infrastructure- Types of infrastructure and their status, including transportation, agricultural inputs, electricity, and hospitals	Site visit
	Social capital and belief systems- Existing community-based organisation and their focuses, social norms and local traditions, local perceptions of hazards	Focused group discussion and interviews
Communication	Existing means of communication and their trends	Trend analysis social map
	Information needs	
	Existing information on available weather forecasts and level of inter-departmental coordination in disseminating such information	
	Availability of and access to information and gaps and limitations	
Ecosystems	Existing ecosystems	Resource map, focused group discussions and small group meetings
	Changing patterns of availability and use of natural resource	
	Impacts of disasters and livelihood practices on ecosystems	

residual impacts of a particular natural event (a drought, say) or human action (like the construction of a large dam) either from an ecosystem or social perspective (Vogel and O'Brien, 2004). In contrast, vulnerability assessments take into account those factors, both environmental and human, which together or separately drive and shape the vulnerability of the receptor (for instance, a community or ecosystem). The potential risks for a specific receptor are assessed with the understanding that there will be a variety of stress events (multiple hazards) over time and that they will occur within a society and environment that have the ability to respond (i.e. that have a internal coping dimension). In short, both external exposure to stresses and the internal capacity to cope with them are important in assessing vulnerability and risk (Vogel and O'Brien, 2004).

Qualitative narratives

While purely quantitative approaches are the vogue, several academics and development practitioners believe in the potential of qualitative, actor-oriented or self-assessments to get a handle on the complex concept of vulnerability. "Storytelling" for some is a powerful methodology for unpacking the

narratives, actions and agency of different stakeholders (Wisner, 2005). Development research routinely investigates the daily lives and livelihoods of the poor using a range of participatory and semi-structured methodologies. A "story," in this context, is essentially an account of an experience of hazards encountered in normal daily life, for example, a community's experience of the changing availability and quality of water or of a disaster, whether an earthquake, flood, or volcano. Such stories help researches infer how patterns of coping or adapting have changed over time or across different generations. The types of questions that they will ask include some of the following: What did your parents do when there was a cyclone or drought? Did they migrate? What strategy do you use now? Have you diversified your livelihood? What do you hope your children will do when the next drought comes? What do you think should be done?

Stories are free-form narratives that can be related orally or through drawings (indigenous or folk art), maps (timelines) or videos. In many societies, stories form part of a tradition of passing knowledge on to the next generation and of recording and "safekeeping" change through different media (from cave paintings to the aboriginal art to digital technology). Stories can also be self-empowering and healing: many of the approaches in post-disaster trauma counselling use storytelling (recall) to recreate a disaster and thereby help the affected cope with their immediate loss, pain and grief, and also to understand what makes them vulnerable.

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 and other dimensions which constitute vulnerability. Such indicators are typically available only at the macro-scale of regions, countries, states and districts and not at 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, including agriculture, tourism, industry, housing and infrastructure (the assets-at risk-approach) to develop a macro-scale indicator.

The quantitative vulnerability index we developed operates at the meso and micro level of the case studies and attempts to balance our concern with the susceptibility to suffer damage and the ability to recover from that damage. Following Woodrow and Anderson (1989), the index also draws attention to non-material—institutional and attitudinal—aspects of vulnerability. Furthermore, it balances local-level perceptions from the field with expert assessments of costs and benefits and the vulnerabilities and capacities that the field team members may have brought to the exercise. Our approach to understanding of vulnerability was the need to develop an integrated approach that could look at both the physical (external hazards and risks) and the social dimensions (internal susceptibility and ability to cope) of vulnerability at different levels and scales in each area.

The sites as mentioned above ranged from disaster-prone hamlets to disaster-prone districts and regions (like coastal Gujarat and Tamil Nadu and the flood- and drought-prone basins of the Rohini and Bagmati rivers in Nepal and Rohini River Eastern Uttar Pradesh). Our vulnerability assessments were primarily, but not exclusively, based on a three-parameters: capacity and vulnerability analysis (CVA) framework combining participatory social vulnerability analysis and physical assessments of both environmental and ecosystem services

TABLE 4.2:
OBJECTIVES AND TOOLS

Step	Objectives	Tools used
1: Situation analysis	■ to identify external threats, e.g. risks, hazards and climate variability ■ to broadly understand who is vulnerable and how are they coping / adapting	■ *Historical profiles:* trends, disaster timelines outlining impacts and coping strategies ■ *Transect walks:* changes in land use, access to water resources ■ *Seasonality calendars:* debt, hunger, fund (credit) flows (differentiated by gender, class and caste) ■ *Community mapping:* access to and control of natural and social resources ■ *Multiple hazard mapping:* floods, cyclones, fire, etc.
2: Analysis of causes	■ to conduct an in-depth analysis of differential causes of vulnerability ■ to identify differential vulnerability (gender, social exclusion) at the community level	■ *Focus group discussions:* with vulnerable groups ■ *Vulnerability ranking matrix:* Developed and used by the team in Nepal (see the Nepal section for an explanation)
3: Assessment of capacities	to assess different individual/ community capacities to cope or adapt in a given social, institutional and governance context	■ *Venn diagram:* mapping community perceptions of 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, and endowments) as well as social networks (capital and labour), physical infrastructures (e.g. cyclone shelters, embankments) ■ *SLDs:* to explore perceptions of change (behaviour, attitudes, and motivation) and the roles of different actors and actions in reducing disaster risk.

(forestry, agriculture, fishing, animal husbandry, watershed as well as of communication and information systems. In addition, we used SLDs to understand the context of disasters, the different dimensions of vulnerability and climate variability, the potential of alternative DRR approaches and the perceptions of disaster by diverse social actors. In proceeding this way, we hoped to fill a gap identified by Davis: "*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). Our method, in contrast, embraces both complexity and dynamism.

We believe that any method of assessing vulnerability should be a complex inter-disciplinary exercise which uses multiple skills of facilitation and quantitative/qualitative analysis to assess both the symptoms and causes of vulnerability. While such an assessment is typically a pre-disaster exercise, because vulnerability is dynamic, there need to be post-disaster assessments as well, not only to track whether or not vulnerability has been reduced but, more importantly, to critically assess which interventions were useful avenues of entry for reducing vulnerability. A good pre-disaster assessment provides a baseline for future monitoring and learning processes and can feed into climate adaptation policy frameworks.

Our aim in conducting qualitative analysis was to link vulnerability analysis with existing livelihood strategies, ecosystem services, physical and social infrastructures, including information and communication systems, in order to identify those points of intervention where we could most effectively strengthen people's ability to adapt and build resilience through a process of transformative change. The steps, the objectives and the tools we used are summarised in Table 4.2.

The insights on vulnerability discussed above constitute part of what we framed as "global knowledge." We also presented communities with other sorts of global knowledge, including climate change projections and the meteorological, hydrological and engineering

aspects of climate change. In each of the four study sites, researchers used all available opportunities to share and explain scientific concepts in the spirit of shared learning as and when applicable. Eventually the process of top-down and bottom-up sharing helped us to identify options for pilot activities. Since these activities were derived from SLDs, it is first useful to describe the process used.

SLDs in field sites

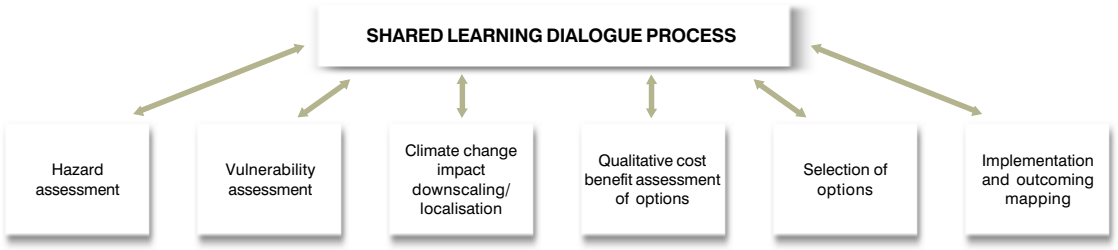
To develop the SLD process, we first oriented local partners to its concepts and then potential approaches for putting those concepts into practice. On a practical level, most partners started by organising an initial series of meetings with village and other communities in the case study sites; these meeting were then repeated several times over active two year field phase of the study. The limitations of this approach quickly became obvious. Because the process for encouraging shared learning was unclear, meetings felt purposeless and often had no set agenda. In addition, the need for shared learning to involve diverse set of actors at different levels, though understood conceptually, was so radically different from the approach typical of many development projects that meetings tended simply to adopt the conventional, comfortable approach in which local communities are the focus. The ability of project staff to facilitate shared understanding was limited and frustrations grew. In response, the partners exchanged extensive notes and emails regarding their local-level experiences with SLD meetings in different project sites in order to clarify both the techniques and the larger objectives now recognised as central to the SLD methodology. This intensive exchange generated the following practical tips on executing the approach.

First, it was recognised that shared learning can't be thought of as the extractive information-collecting method common to many stakeholder consultations. Instead, 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 holding more meetings (discussing exactly the same thing twice is rarely productive); instead, it means holding sequential meetings. Meetings are held on a regular basis, yes, but only when they can either add to understanding by clarifying the perspectives and knowledge of different groups or are required because new information is available.

Second, it is essential to include multiple groups in the SLD process because the impacts of climate change cut across scales and responses require action across groups working at very different levels. Shared learning will not be effective and cannot translate into action if it only involves local communities. It is essential that SLDs be conducted with not simply local communities, but also with the government, the private sector and NGO across scales (local, state, nation, region). District or national level representatives need to be involved to local meetings while locals to national meetings. It is often the case that more meetings are required at the local level in order to clarify issues and concepts to groups that are unfamiliar with global issues, but some level of iteration is required at all levels.

Third, shared learning ultimately needs to be linked to action. As illustrated in Figure 4.2, shared learning involves a cycle in which the initial dialogue forms the basis for the implementation of decisions and that

FIGURE 4.2:
SHARED LEARNING DIALOGUE PROCESS



implementation in turn provides new experiences, which themselves are the basis for new learning. The cycle can either be a straightforward sequential process or one that is driven by episodic events (such as floods) that draw attention to an issue. In the following sections we explain the SLD processes in each case study sites.

Nepal Tarai

We began by creating a broad framework outlining the various steps of the process. Preliminary meetings were followed by a series of in-depth interactions with communities, representatives of community groups and government officials. We used these meetings to formulate an interactive method for carrying out local-level assessments of both the natural hazards and the levels of vulnerability in the selected VDCs and for coming up with disaster risk mitigation strategies.

We held eight SLDs: two national-level ones in Kathmandu and six local-level ones. An attempt was made to include equal members of men and women in each SLD, but it was not possible in every SLD. To ensure equal participation, local partners were asked to visit local VDCs and encourage women participation. The local communities themselves suggested time and duration of the meetings. All the SLDs were recorded, translated and summary prepared. Partnership with the local NGO proved useful. Similarly, the discussions of National-level SLD were recorded and summary produced. Representatives from government and non-government organisations, media persons and representatives of our partner organisations in India participated in the national-level SLDs, whose objectives follow.

- Discuss how the participating organisations approach DRR and share experiences; and
- Discuss possible approaches to disaster risk mitigation and long-term development and options for interventions.

For local-level SLDs our objectives were as follows:

- Share the entire community's knowledge about managing flood disasters, including 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 tool for assessing vulnerability.

The findings from SLDs together with hazard maps, vulnerability assessment and PRA

contributed to the conceptualisation of village level adaptation plans for all four VDCs. The SLD yield better understanding of the hazard at the local level. Bank-cutting is a major hazard as it affected all kinds of landowners. Some of them 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. Main problems particularly pregnant and lactating women faced were lack of toilets and safe drinking water. Inability to commute was their other main problem during flood. Difficulties also were encountered during the SLD process as people were unwilling to cooperate even to female community workers. They wanted to know political affiliation of the facilitators and enquired about the benefits they would get from the study.

Eastern Uttar Pradesh

Our SLDs aimed to identify strategies for risk management that could be used instead of the traditional structural control-based initiatives that the government has been implementing since independence, investing large sums in embankments. We also sought to identify ways to cope with drought that were not based on the expansion of large-scale irrigation systems. This history, we felt, was an important factor informing the nature of our SLDs. Although NGOs have dialogued about alternatives, the ideas generated have not been translated into specific actions on the ground. It was our aim to use our SLDs to accomplish just this practical realisation.

We began conducting SLDs with a view to collecting data and information regarding community perceptions of disasters and levels of vulnerability. We were fortunate that a previous study provided us with a foundation for building our understanding of the characteristics of the area. We initiated our SLDs with a series of conventional focus group discussions about the issues of concern and problems in the village; both community and *panchayat* members participated.

The SLDs were supplemented with scoring and ranking methods to identify (and prioritise) the most severe problems. Preference was given to problems faced by the community at large rather than to those faced by individual households. Once they had been identified, these problems were discussed in depth. In addition, the causes and effects of the hazard and vulnerability were analysed using social maps developed in a participatory manner. The outcome of the SLDs was the identification of a package of interventions that are quite different from the large structural measures that have dominated past flood control efforts and that can be implemented at the village level. These measures were evaluated as part of our larger study of the costs and benefits of DRR.

Coastal Tamil Nadu

SLDs in Tamil Nadu involved intensive discussions regarding the impacts of climate change on coastal regions and potential strategies to respond to them. The SLDs yielded a relatively clear divide between those points where perceptions regarding the implications of climate change and potential response strategies converge among groups of all levels and those where they diverge.

Village-level SLDs: Following an initial scoping process to collect background information and the conduction of a series of relatively unstructured discussions, the SLD process was refined and carefully structured using the following steps:

- The stakeholders and partners in the region were identified.
- Relationships with the NGO Coordination and Resource Centre and with a few other NGOs in the region were cultivated.

- Baseline information on the region was collected and a potential list of villages where we could start our work was developed.
- Villages were selected after prolonged consultations.
- Various social groups such as fisher communities, small and marginal farmers, scheduled castes, landless agricultural labourers, shrimp farmers, self-help group members, women labourers, and village leaders, were identified, taking care to include both groups that are generally perceived as being vulnerable to climate impacts as well as those that are thought to be less vulnerable.
- SLDs were carried out with each group identified. On the day before each SLD, potential male and female participants, anywhere from six to twenty in each group, were identified and prepared.
- SLDs lasting four to five hours were conducted.
- After documenting and synthesising a series of SLDs, a district-level SLD was held and the results of the village SLDs were presented.
- After a gap of a few weeks, local-level SLDs were repeated with more questions and greater refinement. In each site at least three SLDs were done,

District-level SLD: A district-level SLD was organised to share the insights gathered from the village SLDs. The SLD also aimed to promote discussions among district-level officers, agencies and community leaders. Identifying potential participants and arranging logistics took considerable time. The key participants included the district disaster management officer, the District Collector, officials from the fire service, the forest department, representatives of insurance companies, an officer from National Agriculture Bank for Rural Development (NABARD), researchers, an agricultural research centre soil scientist, the Director of the NGO Coordination and Resource Centre at Nagappatinam, the staff of several NGOs, a local cable TV operator, mobile operators, farmer and fishermen leaders, and women members of self-help groups. The day-long workshop was attended by 40 participants.

State-level SLD: The key learning and issues which emerged from the village- and district-level SLDs were taken to one-day state-level SLD workshop attended by state-level officers including the Relief Commissioner, the Revenue Secretary, officials from the Meteorology Department, officials from insurance companies and banks, staff of NGOs, state-level and district-level leaders of fishermen and farmers, and researchers.

The process yielded better understanding of how the villagers of TS Petai and Pitchavaram coped with the difficulties. Every full- and new-moon day, seawater intrudes into backwater channels and spills onto the adjacent fields, severely salinising the surrounding soil and groundwater. In addition, for at least four months a year, agricultural lands are flooding with standing rainwater of considerable depths. The bunds of drainage channels are very weak and made even more prone to collapse by the monsoon rains. The clayey soil prevents percolation so once a field is flooded it takes months to dry. As a result of these phenomena, it is impossible to farm from October to February or March. Most village fishermen have small or medium-size operations. All own catamarans, *thoni* (a two-person wooden boat with no engine) or fibreglass boats and none have a trawler or motorboat. In the past 30 years the village has experienced eight major cyclones, more than 10 moderate cyclones and coastal floods almost every year. Because sanitation is very poor (almost all defecate in the open), the

impact of floods is especially devastating and many women and children fall ill.

The villagers are engaged in farming and fishing, some villagers now do construction work, many have migrated to towns and cities, and a few have tried—unsuccessfully—to cultivate shrimp. Women have started rearing cows and buffaloes, but since there is no veterinary facility near the village, they have to travel 20 km to Chitidambaram every time an animal falls ill. There are 60 self-help groups in the village, most of which were formed after the December 2004 tsunami. They provide loans for household purposes, to set up small shops, and to purchase basic productive goods like farming tools or fishing gear. Government has issued social security cards to all those who live below the poverty line; cardholders get benefits such as compensation for death due to accident and assistance for getting married and meeting funeral expenses, support during pregnancy and delivery, education subsidies for dependent children, and old-age pensions. Villagers are privy to weather forecasts and cyclone warnings broadcast on television and radio from official source such as Indian Meteorological Services. The village also has access to one cyclone relief shelter.

Fifty years ago, the Cauvery delta was irrigated by letting water into the tail-end regions first, a practice that enabled farmers to begin cultivating in June, plenty in advance of the arrival of the monsoon. Later, as water grew scarce, upstream farmers began to help themselves first, leaving tail-end farmers to get water only in September almost three months later, when the northeast monsoon is upon them. The result is extensive flood damage to crops. Rough seas and cyclones also cause seawater flooding. Farmers cannot remember when they last grew a crop in the Kuruvai or Samba seasons; today, paddy or groundnut is cultivated in the Navarai, which starts in December and ends in April/May. During this season even a short spell of rainfall accumulates in land taking months to drain out to the sea.

Coastal Gujarat

As was the case elsewhere, SLDs in Gujarat were conducted at different levels.

Village-level SLDs: The village level SLDs in Gujarat also aimed to reveal resources and systems in the villages. No system of early warning exists and communities are often informed of impending floods and cyclones so late that their actions are reactive than proactive. The dialogue revealed that there were no information on rainfall, floods, cyclones or other issues that could be of value for planning disaster preparedness and mitigation measure at the village level.

The vulnerability mapping process of Sartanpur showed that the economically underprivileged sections of the community reside in the outskirts, from where it is difficult for them to access information, relief and other support services. The SLDs also revealed that the low-lying neighbourhoods become water-logged when there is flooding because they have no drainage systems. The residents of these areas cram into the only available shelter, the Ramapir temple. A question also arose: whether or not all sections of the community are allowed in? Other issues discussed were the fact that the shelter have no electricity supply and women are the most vulnerable group as they lack access to effective means of communication.

District-level SLD: A district-level SLD was organised at Bhavnagar in December 2006. The SLD aimed to share the findings from the field sites with district-level stakeholders. In addition, the district disaster management authority,

taluka-level government stakeholders, NGOs and civil society stakeholders got the opportunity to present their views on the disaster scenario in the district. Detailed account of the various committees formed to mitigate disaster was explained and the need for these committees to collect data on resources of villages was suggested.

NGO staff members and representatives of civil society had a different view of these committees altogether. They claimed that these committees do not function well and brought out the following concerns:

- The committees formed by the government to respond to disasters are *ad hoc* and do not engage in any consultations at the village or any other level. As a result, they are ineffective when disaster strikes and actions need to be taken.
- Because line agencies are not well-coordinated, they do not function effectively in times of disaster.
- In the existing government framework, delegation of the authority and the finances and other locally available resources needed to take immediate action during a disaster is limited. For example, a local chief may have the ability to hire a boat locally but if payment does not materialise the response may not be possible.
- Since the committees do not update their inventory of locally available resources, the information available at government offices is of limited use.

In short, civil society was disappointed with the less than efficient ways that the existing disaster management committees (DMCs) at the village, *taluka* and district levels work.

Doctors gave an account of their role during disasters and asserted their willingness to work as part of a coordinated network. The doctors' association of Bhavnagar in particular expressed its dissatisfaction with the inability of the government to provide adequate information about disaster-affected areas, including information about the number of injured people and the nature of the medical and other assistance required from doctors and other health professionals.

The state-level SLD, besides offering as a platform for the exchange of experiences and ideas, also raised some critical questions for further investigation. First, the factors responsible for and the frequency of disasters must be identified. Second, the effectiveness of DMCs of all levels needs to be evaluated. Participants also pointed out that the vulnerability must be seen at two levels, from the standpoints of both how likely a disaster will occur and the nature of the socio-political context, and that when vulnerability is spoken of, it must be in specific rather than general terms. In particular, vulnerability must be identified in terms of a specific disaster, like a cyclone, flood or drought, and not disaster in general. In terms of assessing the intensity of disaster, the participants brought up the fact that frequency alone need not be the only measurement. Other indicators, such as timelines, the community worst hit, or the long-term or immediate damage can also be taken into account. To promote disaster preparedness, they opined, mitigation should take place at both the community and the household level. Part of mitigation efforts should include the identification of options for transferring or shifting risk by making arrangements for rescue and other supports.

The SLD pointed out that the government must assume an active role in all levels of disaster mitigation, from preparedness to relief and to building resilient livelihoods. It was the

participants' opinion, though, that because networking among the various departments of the government was lacking and those departments had a limited understanding of disaster, the government had failed to fulfil its responsibilities. It particularly failed in meeting its first and foremost responsibility: implementing preparedness measures. More often than that, all the laudable measures the government announced immediately after a disaster were forgotten as time passed, leaving people increasingly at risk as each new disaster strikes.

The SLDs and direct communication with villagers revealed that they face multiple problems when floods, cyclone, and droughts strike and because of high levels of salinity ingress. These problems are both short- and long-term, and have a direct impact upon their livelihoods. The alternative strategies proposed should be based on certain fundamental concerns like their associated economic and ecological benefits, how they reduce risk, of the kinds of policies that can be recommended on the basis of such interventions, who can access them, what potential (like engaging with youth) they offer. All of these criteria need further consideration.

SLDs conducted at the village, district and state levels had strong points of convergence with respect to the impacts of climate change. Perspectives on potential courses of action, however, were less unanimous in their agreement. Where the impacts of climate change were concerned, perspectives on the threat to, for example, coastal regions espoused by the IPCC and other sources broadly converged. Villagers believed they were losing land to changes in sea-level: as our case study documented, they could clearly indicate regions where the ocean had submerged large tracts of land during recent memory. Much of the coastal region is already below sea level and virtually all of it is not more than five metres above sea level. They also claimed that climate change was responsible for the increase in the salinity of coastal lands and aquifers. The villagers were also concerned about the impact of cyclones on coastal areas, particularly the impact associated with any increase in cyclonic frequency or intensity. From the local perspective, agricultural yields and production have decreased by at least 50% due to natural disasters such as cyclones, sea and fresh water floods, and land and groundwater salinity. These very issues are the ones that global actors identify. The 2007 IPCC report also makes similar arguments.

Many strategies adopted to address these problems including diversification of livelihood, communication and infrastructure would be recognised as important across the spectrum of actors, from the global scientific community to local villagers. Others, however, represent points of divergence in perspective. From a technical perspective, for example, the construction of river regulators in large deltaic areas will only provide temporary protection if sea levels rise substantially. In general, structural approaches to minimise the impact of disasters create space for discussion about their effectiveness and consideration of whether alternative strategies to adaptation exist. From the perspective of many villagers, however, such structures provide enough security to make settlement seem a feasible option.

Where the practical logistics of the SLDs are concerned, success depends heavily on their organisation. The programme for a district-level SLD needs to be carefully designed so that key issues which emerge from village-level SLDs are presented one by one and time given for dialogue to take place. Village-level SLDs take time to get participants to move beyond the

conventional approaches that they have experienced or have seen implemented in other areas. Finally, if meetings are to build off each other, there must be a clear record of what was said on a good audio-recording system.

Vulnerability assessment

Nepal Tarai

Since the objective of the study was to identify activities that would enable communities to adapt and reduce disaster risk, the team adopted a bottom-up approach which began with affected communities and was backed up with insights from research and central-level functionaries. Primary information was generated using PRA techniques and household survey. The following specific methodologies were used.

1. The team made reconnaissance visits to the concerned districts and to the headwaters of the Bagmati and Rohini rivers.
2. A social map of the hazards in each VDC was prepared and transposed onto a topographical map (1:25,000) of the VDCs.
3. The households in the identified hazard zone were listed and the vulnerability of each was assessed.
4. A timeline recording trends was prepared.
5. Individual-, local-, and national-level SLDs focusing on people's perceptions of flooding, and the damage it causes to land and crops, the loss of human and animal life it engenders, and its impact on the situations before, during and after floods were conducted.

One of the major focuses of the study in Nepal was to assess the degree of vulnerability. The theoretical aspects of vulnerability founded in the published reports and documents were used to define the parameters of this assessment. After the literature was reviewed to select these parameters, several rounds of discussions were held with experts and other knowledgeable persons. A checklist consisting of 25 weighted variables and seven main components was prepared and discussed by team members and local communities to elicit suggestions for revision. Its components included physical, social, gender-related, economic, and psychological considerations as well as access to communication and to resources. The final checklist was administered to all households in the four VDCs selected. Care was taken to ensure that households in each of the hazard sites were included. Ward-wise results indicated that many households fall in the categories of the severely and highly vulnerable. Overall, 37%, 68%, 83% and 90% of the populations in Devgaun, Rampur Khadauna, Bhasedhwa 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 which contribute most to vulnerability (see Table 4.3). There are no mechanisms for providing weather-related information or early warnings at the local level in any VDC. National radio stations and TV channels do broadcast daily temperatures and rainfall recorded at selected stations, but people rely instead on local indicators such as dark clouds to predict the likelihood of rain. Another factor contributing significantly to vulnerability is the gender imbalance. The information on vulnerability collected was shared with the representatives of the VDCs and used to formulate pilot adaptive measures.

Eastern Uttar Pradesh

CVA, social mapping and discussions with community groups were used as tools to assess

TABLE 4.3:
AGGREGATE AND WARD WISE VULNERABILITY RANKING

	Devgaun				Rampur Khadauna				Bhasedhawa				Brahmapuri			
Ward no.	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).

Source: Dixit et.al., (2007)

the vulnerabilities of the three villages studied. Our findings about the existing village-level vulnerabilities and capacities and other information relevant to deciding upon interventions are summarised in Table 4.6.

Few Households that once simply "coped" with disasters are falling in the category of "improving" because they have been able to increase their incomes through out-migration. But on the other hand there are households whose status has fallen from "improving" all the way down to "declining." It is important to document changes in "coping status," which are influenced by income level as one of the indicator of change. Some times it is the middle income farmers who are less able to cope because they depend on one source of income rather than a bundle of incomes.

Gender is clearly an indicator of vulnerability, especially in relation to health, education, mortality, economic participation, decision-making and safety. In terms of literacy, however, it appears that proactive measures taken in the past have been able to narrow the gender gap in some states where the disparity between men and women was once high (Census of India, 2001). Poor women and girls among are the most vulnerable also because they have little voice in decision-making. Women generally are not well represented politically and are neither consulted nor included in development planning processes.

Women and girls find it difficult to participate in consultations for several reasons, as listed below.

- socio-cultural barriers such as *purdah* system, or not speaking in front of fathers and in- laws.
- poor timing (timings conflict with household chores women are obliged to carry out) inappropriate venues for meetings
- inability to travel freely to the place of meeting and
- lack of free time to attend such meetings.

Though India's 74th constitutional amendment of 1992 has enshrined an institutional basis for encouraging women's participation in political decision-making and for bringing them into the mainstream of development, efforts to actually empowering women and promote gender

balance are in a nascent stage. Numerous constraints need to be overcome to ensure that they effectively participate.

Coastal Tamil Nadu

Vulnerability assessments were carried out independently in all three ecosystems. In order to arrive at a meaningful analysis of the four study villages within the three ecosystems, we used a simple tool with multiple weighted indicators. We used a total of 20 variables classified into five main groups of indicators, as laid out below.

- **Economic indicators**–Dependent on traditional sources of livelihood, occupational mobility (capacity to diversify), net assets, income and membership in a self-help group
- **Social indicators**–Social status, number of unmarried daughters at home, educational attainment, skills in the English language, access to health care, access to or affiliation with political parties, and access to or affiliation with community organisations.
- **Demographic indicators**–Family size, number of family members above 60, and number of family members below 5
- **Access to infrastructure**–Housing facility, access to safe drinking water, access to sanitation facilities
- **Access to communication and transport**–Access to a communication network like mobiles and TVs and access to private transport.

After we determined the aggregate score of all the variables, we ranked households on the following vulnerability scale. The results are listed in Table 4.5

TABLE 4.4:
SUMMARY OF VULNERABILITY: EASTERN UTTAR PRADESH

Vulnerability attributes	Manoharchak (% HH)	Lakshmipur (% HH)	Sonatikar (% HH)	Remarks
I) Susceptibility to physical damage				
a) Mud houses	30	22	27	*Kuchha* dwellings are prone to damage
b) Inundation of cultivated fields	25	45	40	Loss in crop production
II) Lack of safe drinking water, especially during floods	100	100	60	Contamination of hand pumps due to flood water
III) Lack of access to sanitation facilities, especially during floods	100	100	60	Toilets and open areas for defecation are inundated
(IV) Lack of irrigation facilities after floods	70	85	70	Lack of access to irrigation technologies resulting in loss in production
(V) Low-income, landless groups	28	10	40*	No alternative to agricultural labour for generating income
V) Lack of access to information and early warnings	100	100	100	People are unaware about alternative income-generating activities and do not have access to effective warning systems

* includes marginal farmers who are dependent on big farmers

TABLE 4.5:
VULNERABILITY INDEX (OUT OF A TOTAL SCORE OF 100)

Name	Name of community	Number of respondents	Economic indicators	Social indicators	Demographic indicators	Access to infrastructure	Access to communication and transport	Weighted avarage of all indicators
Pichhavaram	SC	18	78	74	28	60	90	68
	MBC	63	72	61	28	65	80	61
	BC	2	66	65	20	80	73	62
	OC	1	50	46	30	37	90	48
	TOTAL	91	70	64	28	57	86	63
TS Pettai	SC	6	77	72	29	77	85	69
	MBC	18	67	60	24	62	80	59
	BC	2	40	61	27	37	64	47
	Total	26	61	64	27	59	76	60

Note: SC=scheduled castes; MBC=most backward communities; BC=backward communities; OC=other communities

Source: Field Survey, August 2007

- >80 gravely vulnerable
- 65-79 very highly vulnerable
- 50-64 highly vulnerable
- 25-49 moderately vulnerable
- <25 less vulnerable

Three levels of vulnerability indices could be made—at the individual household level, at the caste or community level and at the village level. Even if particular household is highly vulnerable, and if its caste group or the village as a whole is less vulnerable, then that household's level of individual vulnerability could be minimised.

Table 4.5, as an example of Vulnerability index of Ecosystem II, shows clearly that vulnerability varies across social groups. Scheduled castes are the most vulnerable in terms of all indicators—economic, social, demographic, access to infrastructure, access to communication and transport. In all three case studies, groups grow gradually less vulnerable as we move from scheduled castes to most backward communities and from backward communities to other communities.

Our analysis shows that villagers face multiple short- and long-term problems, including floods, cyclones, and rapid salinity ingress, all of which have a direct impact upon their livelihoods. Broadly speaking, the existing vulnerability of all three villages is augmented due to (a) ineffective communication of early warnings (b), poor sanitation, especially during disaster times (c) regular flooding of households in low-lying areas (d) fragile coastal ecosystem (e) lack of alternative livelihoods, and (f) lack of access to clean drinking water.

After a series of consultations with the village communities, ecologically-viable, culturally-appropriate, gender-sensitive and economically-feasible pilot interventions were introduced to reduce the risks from floods and cyclones. To choose those interventions we practiced SLDs so that all stakeholders in the community would be able to present their perspectives. Two types of activities were identified: land-based and non-land based. In order to implement options, village disaster committees (VDCs) were formed. They were charged with building the capacity of the villagers as well as making the dissemination of flood and cyclone warnings effectively and timely.

In ecosystems II and III, farmer groups asked gates and regulators of different sizes to be constructed at various points along backwater channels and at the river mouth with a view to restricting the ingress of seawater. They perceive salinity ingress to be the major threat to their livelihoods and believe that regulators will help to conserve freshwater to be used for agriculture. Bio-shields were suggested for few

specific locations, as they do not hinder the movement of boats. These communities also feel the need for strengthening the bunds of drainage channels, strengthening the banks of backwater rivers with long stretches of stone embankments, reclaiming agriculture land, and introducing suitable salt-resistant crops. These farming and fishing communities also wanted financial help for higher education of children and skill training in areas like computers for educated youth. Youths expressed a desire for alternative employment. Many fishermen asked to be trained in skills like carpentry, electrical work and civil construction. Members of women's self-help groups, hoping to acquire skills like manufacturing fish and prawn pickles and tinned fish, expressed an interest in being trained in the fish processing industry. Almost everyone thought the idea of establishing a community FM station to disseminate information during disasters and about the market was a good one. Proper sanitary facilities, including toilets, were seen as very necessary, especially for women, children and the aged. Since groundwater is saline because of the ingress of seawater and polluted by industrial effluents, and since the summer months see a worsening of the problem, safe drinking water was one of the people's key demands. After a great deal of discussion it was decided to stick to non-land based activities only for pilot implementation.

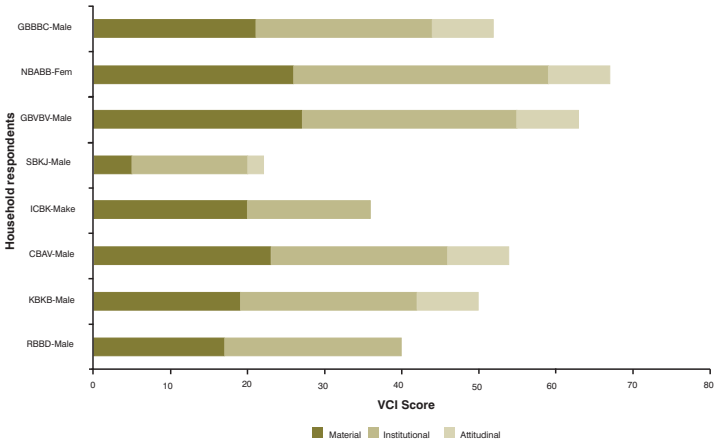
Coastal Gujarat

In all three villages, caste intersects with gender to determine who is vulnerable, where they reside and their access to resources including communication and information systems. In Sartanpar, 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 about impending disasters. Disaster responses do, however, transcend the hierarchical caste system: even those from the lowest strata, like the Devipujak, Harijan and Valmik, are allowed to take shelter in temples—if there is space. But since space is limited, it is likely that the most marginalised communities are denied access at times. Women are amongst the most vulnerable, though their vulnerability varies according to their socio-economic group and access to entitlements. The women of small and marginal landholding families, for example, find it difficult to manage after male household members migrate because they don't own land in their own or names or jointly with their husbands. This creates problems as access to water for irrigation and to credit and extension services is often tied to land ownership or land as collateral. Another problem that particular affects women, who are the primary water collectors, is the fact that water supply systems are rendered unreliable, insufficient and inaccessible when villages are waterlogged. Access to early warning information also has a gender bias: given their heavy workload, women rarely have time to watch TV or listen to the radio and most mobile phones were owned by men. Moreover, none of the women can swim, whereas at least 40% 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 village institutions that could launch collective actions to respond to climate variability and disasters. Fallback mechanisms include social networks, support from the extended family and dependence on moneylenders.

A few details unique to each village are laid out in figure 4.3 (a,b and c).

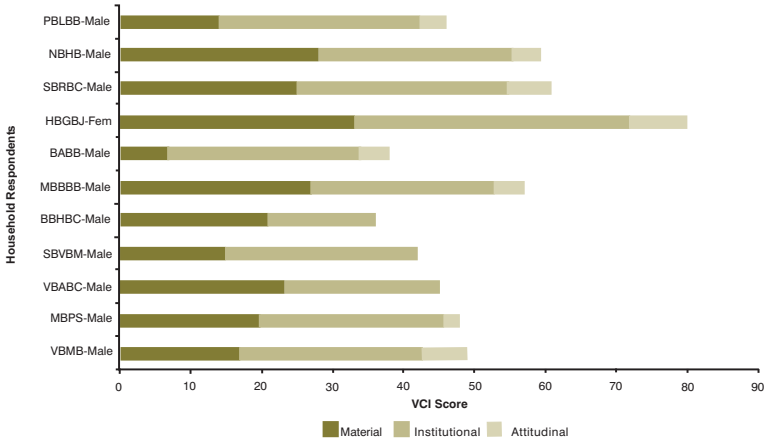
FIGURE 4.3 (A):
VULNERABILITY SCORE TARASARA



TARASARA

The 3,600 people in this village are affected by floods almost every year. About 25% (126 households) are severely affected. In terms of caste, it is the single Jogi household, the 100 Talapda/ Kharwa Koli households, the 17 Kharak and the eight Paliwal household that are most affected. About 78% (410 households) are directly affected by cyclones. The caste groups most affected are again the single Jogi household, as well as 382 Talapda/ Kharwa/Koli, 13 Kharak, two Brahmin, seven Dalit, three Mochi and three Muslim households.

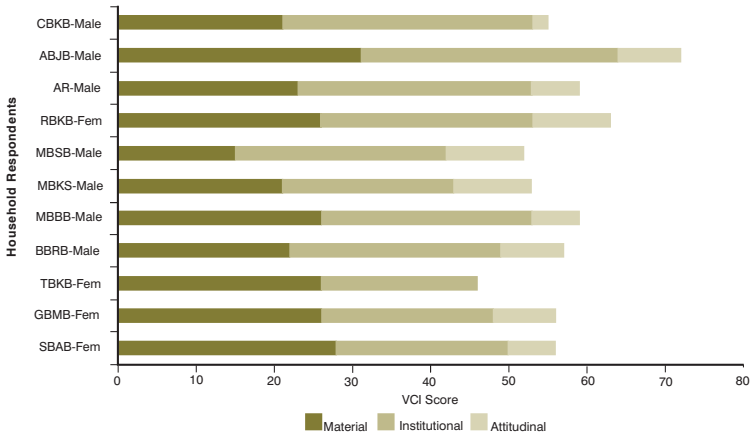
FIGURE 4.3 (B):
VULNERABILITY SCORE SARATANPAR



SARTANPAR

About 79% of the residents (11,000) migrate seasonally. Floods cut the village off as causeways and ditches are washed away and affect about 18% (277 households) severely. Those most affected are six Devipujak, 261 Talapda/Koli and 10 Dalit households as well as 200 fishing households. Of the 1500 affected by cyclones, six Devipujak, 1426 Talapda/Kharwa Koli, three Valand, three Sadhu, and eight Dalit households are among the most affected.

FIGURE 4.3 (C):
VULNERABILITY SCORE KATPAR



KATPAR

All of the land in this village is saline and all of the agricultural land (25% of the total) is rain-fed. There is no irrigation system. Nearly 76% don't even own land. Households are grouped into three neighbourhoods: the main village, Katpar Bandar and the lighthouse areas. Floods affect 27% directly, mostly those in the Muslim, Koli, Bharwas and Devipujak castes. About 45% are affected by cyclones, but the percentage soars to 75% in Katpar Bhandar, which is on the coast and where most houses are *kuccha.*

The above sections discussed the methods and processes used to identify pilot activities. In the next chapter we present the pilot activities implemented in the study sites in Nepal Tarai, Eastern Uttar Pradesh, Coastal Tamil Nadu and Coastal Gujarat. .

5

PILOTING ACTIVITIES

Adaptation to climate change impacts is enabled by taking both targetted activities and creating support for communities at systemic level.

After we conducted SLDs and carried out vulnerability analysis and other tasks, we were well set to identify options for piloting in each site. We arrived at this point using a systematic approach that aimed to bring together both natural and social sciences as well as expert and local knowledge in order to generate an assimilated and synthesised understanding helpful for adaptation. In keeping with our conceptual framework, we attempted to identify options falling in both the autonomous and planned realms of adaptation. The pilot activities that our practical and theoretical exploration suggests can be classified as follows. Before we do that it will be useful to recollect the notion of adaptation in practical term and the difference between planned and autonomous adaptation (Box 5.1).

The following sections present the pilots which each village opted for as a result of the process of interventions discussed in the earlier chapters. After a series of SLDs, the study teams in each site developed a project matrix summarising the options to be carried out in all sites (see Table 5.1). The sites involved four in Nepal, three in Uttar Pradesh, four in Tamil Nadu and three in Gujarat. Their implementation was accompanied by a series of village-level capacity-building programmes at which technical and skill-enhancement trainings were conducted. We implemented the pilots, via four types of groups as follows:

(a) Disaster mitigation group focused on managing DRR-related interventions and advocacy initiatives, maintaining close coordination with other committees, and coordinating relief activities.

(b) Village information and resource centre committee helped plan and coordinate activities, serving as an informal village-level body.

(c) Farmers' group focused on piloting new agricultural techniques and disaster-tolerant crop varieties and helped provide extension services by conducting meetings.

(d) Self-help women's group focused on income-generating and savings and credit activities.

All of these groups were groomed to be self-managed, but they face limitation in several ways. Some of the limitations are highlighted in chapter VI.

BOX 5.1
Specific and system type interventions

Adaptation-specific interventions: These interventions are designed to help communities adjust to the various stresses disasters, more broadly climate and other changes, will inevitably introduce into the physical and social environment, enabling them to evolve new strategies for earning a livelihood. They include efforts to increase and diversify income and provide food security, ensure access to irrigation through community-based irrigation systems, reduce the fragility of existing infrastructure by raising hand pumps and roads, rehabilitating ecosystems by improving drainage and using excess surface water, and establishing early warning systems to improve the communication of vital information.

Support for underlying systems: These are interventions which help to build a community's self-reliance. The support includes building the capacity of a community's self-managing institutions to take control of their development destiny, specifically their ability to cope with disasters and change in an effective manner. This capacity also depends on the nature of underlying systems such as communication, transport, organisation, knowledge management, finance, governance and livelihoods. Such system can help specifically designed interventions to respond to climate risks as a planned response or can facilitate autonomous adaptation. Furthermore, many of the systemic approaches, such as the expansion of communication systems, are being established by the private sector using business models. By supporting the development of systems we can help to spread risks and help to support adaptive capacity. Multi-function systems, such as those for communication, banking, transport and education and activities that strengthen such systems will be cost effective response to respond to climate change impacts. Our efforts were to explore such possibilities and on facilitating local communities in their advocacy for the resources they need to carry such initiatives.

TABLE 5.1:
MATRIX OF PILOT ACTIVITIES FOR ALL SITES

Livelihood and economic diversification	Ecosystem	Organisation	Education and skill development	Financial and risk spreading	Communication for adaptation (climate specific)	Adapted infrastructure
RISK AND ADAPTATION-SPECIFIC INTERVENTIONS						
Creating livelihood opportunities outside affected areas	Forest as buffers	Formation of DRR and rescue committee	Training about flood relief	insurance	Flood warning system	Shelter during floods
Non-farm, livelihoods	Pollution control measures	Establishment of DRR and relief organisations	Targeted strengthening of construction to increase resilience to floods	Catastrophe bonds	Strengthening communication towers	Wetlands conservation
UNDERLYING SYSTEMS FOR RISK REDUCTION AND ADAPTATION						
Increasing ability to access global and regional labour and other markets	Developing productive inland fishery and farming systems	Increasing the number and diversity of civil society organisations– 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 ecosystems as they change	Incubating new forms of business organisations that can utilise and manage local resources	Region-specific skill training (tourism, etc.)	Productive investment of remittance flows	Increasing access to and freedom of the media	Changing approaches to infrastructure design (houses, roads, bridges, etc.) to account for uncertainty)

Adapted from Moench (2007)

Photo: Ashraya Dixit

Electric three wheeler in Kathmandu

Pilot interventions

Nepal Tarai

After using vulnerability assessment to target the most vulnerable households in each of the four selected VDCs, we carried out the following activities as best we could, given, the poor security situation in the Tarai.

Communication and knowledge-building

One key issue in both sites in Nepal related access of global climate science knowledge to locals. The question was, how can scientific insights on the likely impact of climate change be communicated with local communities in the mountains, hills, and Tarai of Nepal? We also faced another question; does local-level understanding match global-level understanding about climate change? Finding answers to both questions necessitated conducting an iterative inquiry into existing knowledge about global climate change, its suitability for the Nepali context, and its accessibility to local populations. We began our inquiry by conducting SLDs to analyse issues related to climate change in Nepal. In addition, we reviewed the literature and government policy and interviewed experts involved in the climate change sector. We also held discussion with media personnel about their understanding of climate change and their methods of disseminating information.

These steps led to the identification of several themes, including the use of fossil fuel-based energy as the cause of global warming, greenhouse effects, and the impacts of changing rain and snowfall patterns and glacial melt on floods, droughts and watershed management. The use of renewable energy sources such as carbon- neutral "safa tempos" (three-wheeled electric vehicles) and carbon displacing biogas plants was identified as being crucial. In addition, the Clean Development Mechanism and the Kyoto Protocol were

recognised as important aspects of the global outlook on climate change and politics. Another issue that emerged was the important roles various agencies involved in climate-related issues play.

After the issues identified were summarized in English, we were ready for the next step: converting the material to a format that could be communicated to general audiences. The question was how to do so and what medium to use. SLDs with the media revealed that FM radio would be the most cost-effective medium and radio drama, the most useful format. Experience had already demonstrated that radio dramas can stimulate the curiosity of listeners if issues are presented and integrated effectively. Our idea was to emulate the traditional practice of

reciting *purana* (religious story) using climate as the topic; our programme was entitled "*jal bayu purana*" or "climate stories". Preparing the drama was a challenge because climate-related topics had to be communicated to non-technical radio-drama actors. It took almost six months of intense work to prepare a script of seven episodes covering the range of climate change issues mentioned above.

The drama was performed by members of a drama production house whose members represent different climatic regions of Nepal: the higher Himalaya, the Middle Hills and the Tarai. In recognition of the current political concern with social inclusion, they spoke local languages. The drama was broadcast over three FM radio stations: Nepal FM in Kathmandu Valley; Lumbini FM in Butwal, Rupandehi District; and Parsa FM in Birjung, Parsa District. These stations were selected to cover the Rohini Basin in Nawalparasi and Rauthaut districts. Before they were chosen, we surveyed stations, collecting data on their coverage and popularity and their willingness to broadcast "*jal bayu purana*."

After they were broadcast, we conducted a random assessment to gather feedback. Listeners found the programme interesting and said that the content helped them understand climate change and its impact. Nonetheless, most thought climate change as a remote event, something important only at the global level, like Al Gore's receiving the Nobel Peace Prize. Listeners shared that problems like poor access to reliable basic services such as drinking water, sanitation, health and education were seriously felt than the impacts of climate change. The ongoing violence in the Tarai was identified as another serious problem. At the same time, they identified many indicators of local changes that could be attributed to climate change. The listeners suggested that such radio programmes be broadcast in local languages in order to localise knowledge. They also suggested that global knowledge needs to be synthesised with local understanding of weather and climate.

The impact of climate change adds yet another dimension of complexity to a social system already undergoing transformative changes and makes the context still more uncertain. Addressing the challenges will involve many different stakeholders and cannot be addressed through prediction and control alone. Instead, the approach pursued needs to be flexible enough to adapt to the information being generated by changing contexts both global and local. Radio drama is one innovative way of grappling with this challenge.

Health and sanitation

During and after a flood, provisioning of clean drinking water and sanitation facilities accessible to affected communities are the high priority tasks as contaminated water and poor sanitation can seriously degrade health, including widespread illness and many deaths. We held a one-day basic health and sanitation awareness training in both Bhramapuri and Bhasedwa in Rautahat District. It aimed to make local people aware about the importance of good sanitation practices during and after a disaster. It provided easy-to-use techniques on purifying drinking water and keeping the surroundings clean. Participants also learned about the importance of hygienic food preparation and washing one's hands after defection. In each village, twenty male and female participants were selected who were associated to health-related works and had influential personality.

Alternative livelihoods

Motorcycle maintenance and electric wiring: On the basis of the job opportunities in neighbouring villages and nearby cities, the

villagers recommended that youths from the flood- affected and backward communites of Bhramapuri and Bhasedwa be provided skill enhancement trainings in repairing motorcyles and electric wiring.

With growing access to roads, the numbers of motorcycle owners have increased substantially in just a few years' time, but people still have to cross the border to the Indian market to have these goods repaired and maintained. To increase its self-reliance, they selected two literate youths from flood-affected families (one was landless, the other's land had been destroyed by sand deposition) to participate in a three-month training. Each was given a settools and trained in an workshop in Gaur bazaar by local mechanics. Both now work in the workshop on a part-time basis, helping their families with their new skills, and are expected to start their own workshop elsewhere in the VDC.

With the extension of electricity transmission lines to Bhasedhwa, Bramhapuri and with the growth of the towns of Gaur and Chandranigahapur, electric wiring has emerged as a source of livelihood. The villagers identified two literate youth from flood-affected families for three months of practical training under the supervision of a trained electrician.

Banana cultivation: During the SLDs, people also identified agricultural-based opportunities including the cultivation of bananas, watermelons, and pointed bitter gourds on 10 *bigha* of flood-damaged land in Bhasedwa VDC east of the Lal Bakiya River. Eighty banana seedlings were provided for planting.

Eastern Uttar Pradesh

The options the villagers identified for implementation in Eastern Uttar Pradesh are summarised in Table 5.2

In the following section we describe specific activities in more detail.

Agriculture-specific interventions

The agricultural interventions implemented in the three villages were basically the same as the ecological and social conditions were similar, but in Sonatikar and Manoharchak, multi-tier cropping was also promoted to overcome the loss of spring-harvest crops. Responsibility for these interventions fell on farmers' groups, one of the four types of groups established to carry out the responsibility of implementation. In order to increase the income of the farmers and enhance local food security, small and marginal farmers got support to implement the following initiatives:

a) Early variety of paddy
b) Mixed and integrated farming
c) Seed production
d) Vegetable production
e) Nursery-raised seedlings and
f) Multi-tier cropping

*Early variety of paddy (NDR 97)**:*** Because the districts of Gorakhpur and Maharajgunj are affected by both flood and drought every year, farmers can grow only one crop during the *rabi* season. Because cultivating *kharif* (autumn-harvest) rice takes at least 135 to 150 days, and is cultivated in mid-June and harvested in October, when floods arrive in early September, as they usually do, the crop is washed away of damaged. And when the monsoon is late or irregular, the rice doesn't get water in crucial periods and productivity is low. To tackle these problems, we searched for a variety of rice that grows quickly and needs little water.

NDR-97, a variety developed at Narendra Dev Agriculture University, takes only 90 to 100 days to grow, so it can be harvested before the onset of flooding. It can be planted a little earlier than

TABLE 5.2:
PILOT ADAPTIVE MEASURES FOR UTTAR PRADESH

	Lakshmipur	**Sonatikar**	**Manoharchak**
Description of Village	Population-1765 (M-726, F-679, C-360), agricultural land-125 ha, irrigated-95 ha, non-irrigated-30 ha, Total HH-199, 80% small farmers	Population-525 (M-242, F-198, C-85), agricultural land- 78 ha, irrigated-68 ha, non- irrigated-0 ha, Total HH-100	Population-467 (M-198, F-86, C-83), agricultural land-45 ha, irrigated-29 ha, non-irrigated-16 ha, Total HH-104
ADAPTATION-SPECIFIC INTERVENTIONS			
Diversification/ Ecosystem			Early maturing and water-tolerant crops, fodder conservation
Disaster risk reduction	Provision of irrigation pumps, maintenance and disinfection of hand pumps, laying of drainage pipes on both sides of embankments and roads dependent upon local support of local people	Provision of community tube wells, maintenance of hand pumps	Provision of community tube wells, maintenance of hand pumps, training in hygiene practices, construction and raising of toilets making and raising,
Organisation and incubation	Establishment of self-managing institutions, including farmers' and self-help groups and a village health committee, and of village resource centres	Establishment of self-managing institutions, including farmers' and self-help groups and of village resource centres	Establishment of self-managing institutions, including farmers' and self-help groups and a village health committee, and of village resource centres
Skill development	Awareness programmes and trainings in intensive farming, the design and construction of portable raised toilets, and personal hygiene	Awareness programme on disaster mitigation and trainings in intensive farming, vegetable production, seed production, water-tolerant crops, composting, and personal hygiene	Awareness programme on disaster mitigation, trainings, exposure visits
Financial initiatives and risk spreading	Income-generating activities such as mushroom production, goat rearing, fishery, poultry rearing and candle-making.	Income generating activities such as mushroom production, goat and poultry rearing, fishery, and candle-making	Income-generating activities, such as mushroom production, kitchen gardening, goat and poultry rearing, fishery, and candle-making
Communication	Village-level information centre, early warning system, communication centres, community FM radio, mobile phones	Village-level information centre, early warning system, communication centres, community FM radio, mobile phones	Village-level information centre at village level, developing an early warning system with mobile phones and community FM radio but will depend upon external stakeholder's support
SUPPORT FOR UNDERLYING SYSTEMS			
Education	Training in seed production, farmers' credit cards, crop insurance, ensuring availability of IEC materials, exposure visits	Training in seed production, both vermi- and, ensuring availability of IEC materials, exposure visits, farmers' credit cards, and crop insurance	Training on farmers credit cards (KCC), crop insurance, ensuring availability of IEC materials through resource centre, exposure visits.
Transport	Boats, bamboo bridge	Boats, bamboo bridge	Boats, bamboo bridge
Financial mechanisms	Linking banks with the self-help groups and savings and credit organisations	Linking banks with the self-help groups and inter- loaning	Linking banks with the self-help groups and inter- loaning
Organisation	Community irrigation management, setting up systems for community contribution to repair water pumps	Community irrigation management	Community irrigation management, labour contribution by people to drain excess water
Livelihood	Off-season vegetable and mushroom farming, seed production, kitchen gardening.	Off-season vegetable and mushroom farming, seed production, kitchen gardening and vermi-composting	Vegetable and mushroom production, seed production, kitchen gardening nursery raising, vermi-composting, goat rearing, fishery, incense-making, and candle-making

BOX 5.2

Cultivation of improved paddy

Area covered: '175 acres
Crops: Wheat, NDR-97 paddy, and vegetables
Target group: Poor farmers and women-headed families identified by the community
No. of families benefiting: 365

other *kharif* crops, in mid-May, because it can withstand the heat of summer, and is harvested in mid-August, just before most floods occur. One problem which remains, though, is that flooding can come as early July, as it did in 2002 in which case even NDR-97 would be damaged. Because the climate is growing increasingly erratic, it is best to adopt planned agriculture which can respond to variable climate characters.

Mixed and integrated farming: Floods damage most of the standing crops, but when farmers cultivate red and black lentils in upland parcels where water does not stay for a long time, they can offset the loss. The sale of these crops can provide additional income and add a rich source of protein to a chronically deficient diet. In Eastern Uttar Pradesh, the monsoon has been erratic for many years, resulting in low production of and damage to *kharif* crops like rice. Pulses, in contrast, require little water and will grow even during drought conditions. In addition, vegetables like bitter gourd, coriander, ladyfinger and green chillies can be cultivated and harvested before the monsoon begins. They can be used to meet household needs or they can be sold, generating a tidy income.

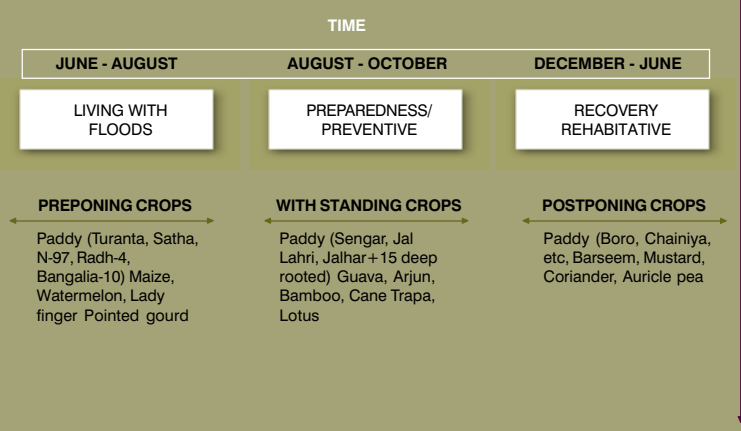
Once flood water has drained from agricultural fields, farmers can locate relatively dry areas and plant "kitchen gardens" with vegetables. Through the appropriate and optimal use of land and the judicious use of a household's waste water, kitchen gardening can be adopted in disaster- affected areas at a very low cost. This practice not only mitigates the losses incurred due to floods but is also for a source of livelihood. It also reduces market dependency and provides people with fresh vegetables.

Seed production: To increase yields, seeds must be of good quality. In flood-affected regions, small and marginal farmers struggle with this problem as floods often destroy their own stores and the seeds the government provides are often of low quality. They can buy good quality seeds in the market, but these are expensive. If seeds could produce and store locally, they would increase their self-reliance. With this aim in mind, GEAG trained 32 farmers. Eleven out of 32 farmers, 11 of whom are linked with a local organisation that purchases seeds directly from these farmers and gives them a better price than that they would get on the open market.

Vegetable cultivation: A mixture of clayey and sandy soils, such as found along riverbanks, is best for cultivating vegetables. Farmers with such land can cultivate vegetables to earn their livelihood. Vegetable cultivation is a year-round occupation which takes little time and has a nearby market accessible for minimal transportation costs.

Nursery-raised seedlings: In flood-prone areas, the non monsoon period brings irregular rainfall and heat damages many seedlings cultivated in the field. To increase survival rates, which are currently very low, seedlings can be raised in homestead by using whatever plastics bags, cups or pots are available. The technique also works in cold conditions. Farmers were taught how to make holes in the bottoms of the containers and use an appropriate amount of compost serve and other techniques at regular

BOX 5.3
Seasonal and spatial crop management



SPACE

	Kharif (June-Sept)	Rabi (Oct-Mar)	Jayed (Mar-May)
Upper Layer (on Machan)	Nenua, Bitter gourd, Satputia, Bottle ground, Pumpkin, Cucumber, Kunduru	Bottle gourd, Bitter gourd, Sem, Nenua	Cucumber, Bitter gourd, Kundru
Standing Srops (on the bunds)	Archar, Brinjal, Chilli, Spinach	Soya, Brinjal, Chillis	Ocra, (Lady finger), Maize, Brinjal
Ground Layer	Groundnut, Elephant leg, Spinach, Kulthi, Urad, Turmeric	Garlic, Obnion, Palak, Raddish, Carrot, Methi, Spinach, Tomato, Coriander	Onion, Spinach, Tomato, Coriander

Source: Wajih (2009)

intervals. As a result, they were more able to germinate and raise seedlings successfully until they could be transplanted.

Multi-tier cropping: This technique is effective on lowlands plagued by water-logging. Multi or two-tier production of vegetables can be grown on beds five to six feet high from the ground. Multi-tier cropping begins after potatoes are harvested in March and continues till October. It requires building a bamboo frame with two or more beds. Pumpkins, bottle gourds, bitter gourds, and beans can be cultivated on the upper layers of the frame without touching the ground while other vegetables can be cultivated on the lower tier.

DRR-specific intervention

Raised road with public participation: One major issue is restricted mobility. In many villages flooding submerges road. To counter this problem in Manoharchak, where the main Chak Road is submerged for long periods, the disaster management group meeting decided to elevate it to improve mobility. About 462 worked together to raise the road four feet using soil that flooding had deposited. GEAG encouraged their work by providing participants with food grains.

Raised handpump and water chlorination: Accessing safe drinking water was a primary concern during floods because all the existing sources were submerged and the chance of contamination was high. To counter the problem, villagers raised six India Mark II hand pumps four feet each and constructed concrete platforms around them. Women have particularly benefited as they no longer have to travel kilometres in search of clean water. DMG sent four people from each village to attend a training programme on water and sanitation organised by the Air Force. These groups shared their knowledge with other villagers.

Rehabilitation of linkbridge: During the flood of 2002, both approaches to a bridge that connects Bagailari Satguru village with Harizan Tola was damaged hampering mobility. In just five days, using theirown resources the local

Photo: GEAG

Photo: GEAG

disaster management group (DMG) repaired damage. They cleaned pipes and used earth from the barren land close to the bridge and filled the breached sections and established mobility.

Relief support during floods: During a flash flood on 30 July, 2007 the Domra Jardi embankment between Ranipur and Aurahiya was damaged and within five or six hours 25 to 30 villages had been submerged and around 25,000 people affected. The DMG assisted the *panchayat* in evacuating people to safer place by making boats available and ensured that government relief packages were properly distributed to the affected. Its effort was successful because the community is more aware and more willing to support the local government in fulfilling its responsibilities.

Grain bank: Though villagers do have several traditional ways of preserving food for months of food stress, they were looking for additional ideas. The women members of the DMG was inspired by an exposure visit to see grain banks, raised structures of earth or other locally-available materials with the capacity of to store at least 200 kg of grain, to build their own in Manoharchak. Every member committed to donating a fixed quantity of grain to the bank after the *rabi* and *kharif* seasons.

Advocacy initiatives: Through their collective efforts, local communities have increased their ability to minimise the impact of droughts. With support from GEAG, they have undertaken initiatives to understand how social safety can be helpful in minimising impacts of disasters.

Public hearing: The community group organised two public hearings on the issues of compensation and DRR activities respectively. District-level government officials also participated in the program**.** The first hearing was held on 3 January, 2008 to discuss the compensation provided to families affected by the 2007 flood. Each was supposed to receive a specific amount on the basis of the land owned. Such a uniform rate, however, did not adequately compensate people for their losses. In addition, the list of the affected had a number of irregularities and the names of many affected persons were left out. Another problem was that the affected did not have bank accounts so they could not make use of the account payee cheques that was distributed to them. The Secretary, the chief, members of the Block and District Panchayat, the Health Officer and the Forest Officer participated in the meeting, while the District Magistrate chaired the hearing. In the discussion the concerns of the local people was better appreciated.

In May 2008, the DMG organised a second public hearing after several sections of the embankment were damaged. The members demanded that the damage be repaired, hand pumps raised, community toilets built and those affected by the 2007 flood compensated. The District Magistrate of Maharajgunj, who

BOX 5.4
PAS in Eastern Uttar Pradesh

After the flood in 2007, village information centres were established in all four villages of Uttar Pradesh. A member of the village disaster management group was selected as the anchor person and given the responsibility to regularly dialogue with the community and with the GEAG, as well as to update information, maintain regular communication with other disaster management members, coordinate meetings with other groups, manage the visits of visitors and assist in organising local-level SLDs. A Public Announcement System (PAS) with microphone and amplifier has been provided to each centre so that during emergencies message can be broadcast to the entire village in a short span of time. In addition, these centres, as well as other community places, display a list of radio programmes related to weather, disaster, and agriculture supplied by All India Radio. More villagers are listening to these programmes. The centres also collect and provide information regarding government relief programmes and any locally relevant developmental schemes at scheduled meetings run by the anchor person. The GEAG facilitates the process and helps the anchor person procure block- and district-level. For their part, the other members of the disaster mitigation group collect information about river water levels at different points from the local office of the Irrigation Department and give it to anchor person. When no information is forthcoming, as is often the case, they measure the depth on their own, using long bamboo poles. The anchor of Manoharchak, said, "We not only collect and disseminate information but also help people to broadcast village-level issues through organising public hearings". He added that in 2008 two public hearings were held and that for the first time, the additional district magistrate took part actively and wrote letter to the Irrigation Department requesting it to repair the damaged section of the embankment. Tripathi termed the event an icebreaking one, in which a district-level government official took part in village affairs and acknowledged the importance of local wisdom.

attended the hearing, issued a government order to the concerned departments to take prompt action.

Foot march on Domri Jarda Embankment: The floods of 2007 had badly damaged the Domri Jarda embankment in many places and would not be capable of withstanding future floods. Close to the village of Bagdulri three-quarters of the structure was damaged which threatened that village as well as Lakshmipur, Manoharchak and Ranipur. In case of a flood, altogether 20 hamlets and 2,000 to 3,000 acres of agricultural land will be affected. Because the concerned authorities did not act, the DMG organised a protest march with men and women participants from six villagers from Ranipur to the Paniyara Block office. They gave the concerned department a petition and demanded immediate action.

Eco-systems strengthening

Construction of drainage systems: In between Manoharchak and Lakshmipur, there were around 500 acres of waterlogged agricultural land belonging to seven villages. Over time, the drainage passage had become blocked because the Irrigation Department did not maintain it despite the repeated pleas of the people. At a meeting with the GEAG, the villagers come up with a plan to construct a 400-m-long drainage channel to connect the passage with a water channel. When they shared the plan with the village *pradhan* and the Irrigation Department; the *panchayat* agreed to help and the Irrigation Department provided three hume pipes. Some villagers gave land to build the channel. On the day of construction itself, 170 contributed their labour and the GEAG provided food grains for the day's work. In the process around 170 people participated and got some employment within the village. The more than 620 families who benefited form the action reported having a good wheat harvest in 2007.

Community-based irrigation system: The majority of small and marginal farmers in Eastern Uttar Pradesh are badly affected by drought because irrigation infrastructures have so deteriorated that irrigation water is scarce. They either have to pay the high price of renting irrigation pumps or risk losing their crops.

In response, the village resource and information committee (VRIC) decided to improve access to irrigation facilities. Tube wells were ruled out as being too expensive, but a community-based irrigation system comprising of pumps and pipes was seen as economically viable. As per agreement, the GEAG provided the capital cost for the equipment and the VRIC both and all other costs, including those of operation, management, information and coordination. The equipment that was purchased is now used by farmers, who agree to follow certain written rules and regulations for accessing it and to pay a penalty for any damage or loss. Using pond or river water, farmers are now able to cultivate once barren plots and to improve irrigation on under-irrigated land.

Tamil Nadu

The SLD and vulnerability analysis in Tamil Nadu helped identify the existing prevalent responses by the people and the government. As explained in chapter 3 the Cauvery River delta, which encompasses the whole of Nagappattinam District and parts of Cuddalore District, is a low elevation coastal zone with few areas 10 meters or more above sea level. 56% of the land lies below sea level and an additional 18% of the land lying just at sea level is waterlogged and marshy. The delta is crisscrossed by a 1,800 year-old irrigation system comprised of a complex network of canals, rivers, channels and drainage system. Due to its flat terrain, the region is prone to flooding from drainage canals and seawater, particularly during the October to December northeast monsoon when most of the rain falls in the span of a few days and is often combined with cyclones or high wind storms.

Because people have been living in these areas for so long, their livelihoods have actively shaped and are shaped by the ecosystem zones in Tamil Nadu. Three distinct ecosystem zones were identified along the Tamil Nadu coast:

- The **first ecosystem** encompasses marine and backwater river reaches where fishing is the principal, or often the only, source of livelihood.
- The **second ecosystem** represents areas in which both fishing and agriculture co-exist.
- The **third ecosystem** is the one in which agriculture is the main occupation, but cultivation is carried out through the broadcast method (seeds are tossed by hand over a broad area, rather than planted in furrows).

Each ecosystem-livelihood zone has unique climate-related vulnerabilities that will be further exacerbated by climate change. Additional human-related pressures, such as the large number of chemical industries located on the beach and discharging effluent directly into the sea or backwater rivers, are challenging the viability of traditional livelihoods. Though many residents of Pichavaram and TS Pettai migrate successfully to do unskilled construction work, job opportunities are limited and alternative livelihoods, especially ones suitable for women or other individuals for whom migration is not an option, are needed. In March 2007 MIDS began by conducting village-level shared learning dialogues (SLDs) with various groups in order to ascertain their views on issues such as vulnerability and needs, current government interventions, and local knowledge on climate change and disaster risk reduction strategies. These discussions generated many suggestions for what pilot project to implement.

1. **Hard resilience options**: The fishing community advocated that three one-way regulators be installed along a stretch of five kilometres to arrest the ingress of seawater but still only allow surplus fresh water to flow into the sea. They also suggested raising the five kilometres of bunds along drainage channels with stone embankments

BOX 5.5
Critique of options in Tamil Nadu

The pros and cons of each suggestion was thoroughly discussed and debated not only with the village but also with project partners. It was decided in the end that structural interventions like the construction of shutters and seawalls is not suitable for coastal villages vulnerable to extreme climate events and sea-level rises. Furthermore, it was agreed that non-agriculture-based interventions would be better than agriculture-based ones because both the soil and groundwater have been rendered highly saline by seawater ingress. The idea of a community radio seemed a problematic as the capital investment is high and the likelihood of its surviving after the duration of the project term was low as neither the community nor the *panchayat* was particularly keen to shoulder the responsibility of continuing its operation. The MIDS group preferred the idea of ecosanitation toilets but feared that using human waste as manure would result in a culture shock. Since the scale of investment required for Mango cultivation was beyond the scope of our pilot adaptation activities, we suggested that the district administration take uo this proposal. Local communities felt that the tree plantation will be burdnesome to maintain. The villagers rejected sea weed cultivation since they thought that the type of sand and climatic conditions were not favourable. Since the rearing of poultry, goats, sheep and cows was already supported by local NGOs in Pitchavaram, this intervention would simply duplicate the efforts. In many case, villagers raise livestock on their own and were sceptical that this activity would enhance their livelihood security. Fresh or brackish aquaculture seemed unsuitable given that the experiment in prawn farming had proved to be a failure. Thus freshwater aquaculture, emu farming and communication intervention were selected for piloting.

2. **Community radio:** The MIDS team proposed starting a community radio to spread awareness and information among local people, in order to broadcast weather reports to contact fishers at sea.
3. **Ecosanitation toilets**: For improved household sanitation
4. **Mango cultivation:** Since mango is a main crops, we considered developing a mango pulp factorty with the cooperation of self-helps groups.
5. **Tree cultivation on private land:** This project is being considered for Pushpavanam under the Union Government scheme. We met concerned authorities like Dr. Balaji, Member Secretary of the Forest Commission, wrote an application to the PCCF to actuate the scheme. Data was collected in order to select beneficiaries and the concerned Conservator of Forest of Trichy Circle[1] was contacted. We are still awaiting a reply.
6. **Seaweed cultivation:** Seaweed cultivation was considered
7. **Training:** A number of training possibilities, including training in computers, communications, and spoken English, were also considered and rejected because the fact that the computer centre is far away and public transportaiton is lacking or infrequent made the village community unwilling to pursue it.
8. **Freshwater aquaculture:** Freshwater aquaculture was finally settled on as the adaptive strategy best suited to local conditions after it was discovered that each household already has a small pond for conserving water for domestic and gardening purposes and that the *panchayat* has 40 village ponds, half of which are used for bathing, washing and feeding cattle and half of which are used for agriculture. In addition, it was found that freshwater aquaculture can generate a substantial income in just five to seven months. After many SLDs were held with the village community, members of the *panchayat,* self-help groups, and officials associated with fisheries in Chidambaram and Chennai, it was suggested that some of these ponds be converted into fishponds. Through the complex process

[1] This is a forest management unit.

of SLDS, we have reached a decision to promote freshwater aquaculture as our pilot activity.

9. **Poultry farming and livestock raising**: These options were identified as income generating activities.

After series of SLDs not all option were considered viable rejected (see Box: Critique of Option). Our team decided to introduce emu farming (through the SHGs), fresh water aquaculture, computer education (to the school and collage drop outs) and communication system as possible interventions.

Livelihood diversification

Freshwater aquaculture: The village of Pushpavanam has around 40 public ponds, 20 of which are used for bathing and for cattle and the rest for agricultural purposes. In addition, almost every house has its own 0.2-0.5-acre pond, which they use to irrigate their gardens and to meet domestic needs. There are about 3,779 household ponds in all.

Shared learning dialogues (SLDs) with the general community, members of the Panchayat, members of self-help groups (SHGs), and fisheries officials revealed that some of these ponds could be converted into fishponds and that fish farming could generate a substantial income within seven months. Our idea was to demonstrate that existing small ponds could be made lucrative by raising freshwater fish in them. This initiative, we felt, would provide an alternative livelihood in an environment whose agricultural system is failing because of highly saline soil and groundwater salinity and fierce cyclones. Just in the last 20 years, Puspavanam, which is surrounded by brackish water and seawater, has lost 100 m. of shoreline and experienced surges in salinity levels, rendering traditional farming increasingly less profitable. Fish farming, on the other hand, was seen as a step toward diversifying livelihoods and an enterprise other villagers could also replicate. Following further discussion with the Fisheries Department, the community and the president of the Panchayat, the largest six public ponds were selected for pilot implementation. One addition, public pond, Ayyankulam, was also chosen; it was to benefit a SHG of women belonging to scheduled castes.

On 28 December, 2007, 15,375 fish juveniles were dropped into each of the seven ponds comprising a total area of 7.5 acres. The management committee and the village community were fully engaged in the process. Then display boards providing details about the project were erected. The total cost of the programme was IRs.24,604.00 and the expected return was around IRs.100,000.

The MIDS team visited the village regularly to help to monitor the process. The project soon fan into problems, however, as some villagers were against raising fish. They claimed that the feed pellets dirtied the ponds, making them unsuitable for domestic uses. Their argument has generated misunderstandings between certain sections of the population and the management committee. The *panchayat* president has continued to support the project as he sees it as an important fallback in times of crisis. Just before the fish were to be harvest, the monsoon rains arrived, unexpectedly early. The harvesting has been postponed until the dry season. Thus far, fish growth is satisfactory and a good harvest is expected. Exactly what the result will be, however, remains to be seen.

The only major hurdle the project faces is the fact that some villagers believe that ponds used to raise fish can be used for no other purpose. They argued that once fish pellets are added

the water becomes too dirty to use for domestic purposes. A long-term solution to this objection has yet to be found. Other more minor difficulties are that the intervention is location-specific and that it requires either the conversion of hundreds of existing ponds or a willingness on the part of farmers to invest their money in digging new ones.

Emu farming: Emu farming has emerged as one way to diversify income sources. The intervention was introduced by MIDS through selected self-help groups (SHGs). It was chosen for a pilot project because emus can easily adjust to the extreme climate events that plague coastal villages. Before the enterprise was implemented, an analysis of the demographic, socio-economic and physical vulnerabilities of the village was conducted. The process enabled us to select seven self-help groups in Pitchavaram and three in TS Pettai.

The capacity and interest of each SHG was assessed through SLDs. Factors like whether or not members have the space required, their economic status, their total savings, their credit and savings transactions and their degree of vulnerability were investigated. Seven SHGs in Pichavaram, four women's groups and three most backward community men's groups, and three women's SHGs in TS Pettai were selected. Of the female Pichavaram SHGs, one was a scheduled caste group, one a backwater caste group, and two, most backward community groups. In TS Pettai village, there was one scheduled and one backward caste groups and one most backward community group.

Photo: MIDS

Emu birds

After a pair of emu begins laying eggs, they become profitable. Each egg can be sold at least for IRs. 1,000. A juvenile female lays 18-22 eggs a year, but after four years, when she is mature, she will produce 45-55 eggs annually. A pair of two-year-old birds can be sold for IRs. 60,000. Emu farmers are not vulnerable to climate change as emus can adjust relatively easily to hot and cold climates and are not bothered by rain or storms. They only need small fenced plots of land, which are widely available in the study villages.

A village committee with the president of the Panchayat as its convener was set up to monitor and supervise the 10 SHGs until these birds lay their first eggs. Now the emu has become a hot topic of discussion. People in Pichavaram discuss these birds in tea stalls, while shopping, at bus stops and wherever there is a gathering.

The likelihood that emu farming will be replicated is high. Already, people from neighbouring villages visit Pichavaram and TS Pettai to enquire about emu farming and one farmer in North Pichavaram has started his own farms with two pairs of birds. A few of the original participants have bought more than 10 pairs of birds with their own resources. Once the emus begin to lay eggs, it is likely more farmers will be encouraged to get involved.

The initiative is not without limitations. First, since emus are new to the area, farmers need special training to raise and care for them. In addition, they are expensive: a three-month-old pair costs Rs.15,000. In addition, the monthly cost of feeding them a special feed is IRs.1000 and there is an 18-month time lag before the emus first start laying. Finally, until they are six months old, they need to be kept protected from dogs and other animals in a fenced in enclosure.

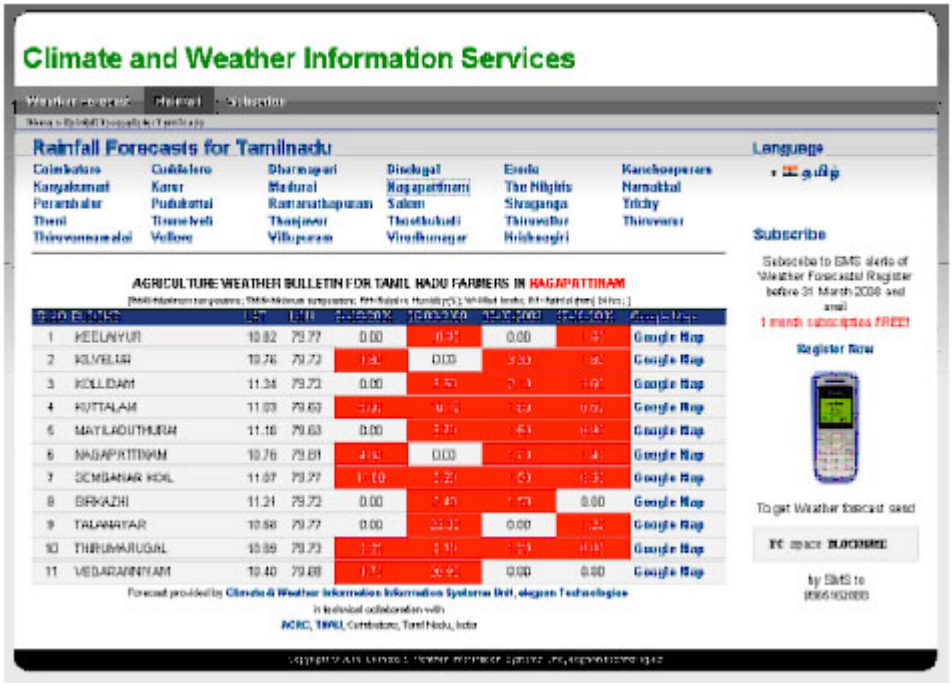
We deliberately chose groups over individuals to ensure the benefits would be more widespread. Of the seven groups in Pitchavaram all three male groups were from the most backward community groups. Of the four female groups, two were most backward groups, one was a backward group and one was a scheduled caste group. In TS Pettai all three were female groups, one each of schedule castes, backward and most backward. The training took place within the villages but participants also toured emu farms in other parts of the district. Altogether 7 self-help groups were selected to receive emus. A contract and insurance policy was worked out with an emu-distributing company and an eight-member village monitoring committee was formed to monitor the initiative.

Communication systems

The interventions in communication systems involved the following three activities.

Weather alerts through sms: In February 2008, when we surveyed the villages, Pushpavanam had 410 mobile phones in use; Vanagiri, 385; Pichavaram, 202; and TS Pettai, 39. Roughly 70% of all households had at least one mobile number. Because of the high mobile phone use

FIGURE 5.1:
FOUR DAY WEATHER FORECAST FOR FARMERS IN TAMIL NADU



Source: Magotra and Carter (2009)

in the selected villages, MIDS decided to use them to send weather alerts and create an early warning system. In collaboration with Ekgaon Technologies and Tamil Nadu Agricultural University, MIDS implemented the project to gauge how well the technology would work and to identify factors which reduce the effectiveness of using short message services (SMS) to spread early warnings.

SMS began to be used for four-day advance weather alerts on 17 March 2008. The information provided included temperature, wind speed, humidity, and rainfall. The timing of the messages was a concern, especially for fishermen at sea, who need time to bring their boats in if the weather is predicted to turn stormy, and there were many instances when no message got through. During the months of April and May 2008, pilot villages did not receive any early warning messages at all. Furthermore, even though the SMS forecast was sent four days in advance, it often reached the recipients after a one- or two-day delay.

Mobile users said they found the idea interesting but were dissatisfied by the content of the messages. For those unable to read English, the messages were useless. In fact, one of the main drawbacks of using mobile phones for early warning is that they do not accept local language scripts. Even for those who can read English, the messages were of limited use initially because the abbreviations used were complex. Once they were briefed, however, they did begin to make sense of the information. Still, many found it difficult to understand the concept of humidity and its relevance to their livelihoods.

The general opinion that emerged was that there was nothing special about sending a routine weather report via SMS, especially as it was not issued in an understandable language. Users said that they did not find the information about weather useful for any specific agricultural activity. However, they did say that information focused on agriculture, including, for example, the prices of agricultural products at the nearest market and the availability and prices of seeds and fertilisers, would be useful.

The pilot revealed that our expectations of the scope of mobile phones for transmitting information were belied by local realities. The needs for information are different as is the ability to understand and utilise weather information. There is a tremendous amount of room for improving the content of the messages. At the same time, it also became clear that once the nature of the messages is improved and the speed of communication increased, the mobile phone could play a vital role during times of emergency needs.

Despite the very limited success of the pilot, the potential for using the mobile phone to transmit early warning messages during extreme weather conditions is high. As a result, Ekgaon Technologies, Tamil Nadu Agricultural University, and MIDS plan to pursue this approach, developing genuinely useful climate alerts. One change will be to use Tamil; another will be to make sure that fishers on the seas get the information they need in a timely fashion. In particular, we plan to establish a helpline which will disseminate alert messages for given areas using a voice-based menu supported by local language voice recognition technologies. We plan to test this service for three months and then gather feedback from users.

Using television to send weather alerts: The government of Tamil Nadu is distributing free TV sets to every urban and rural household that does not already have one. Nearly seven million sets have been distributed and another four

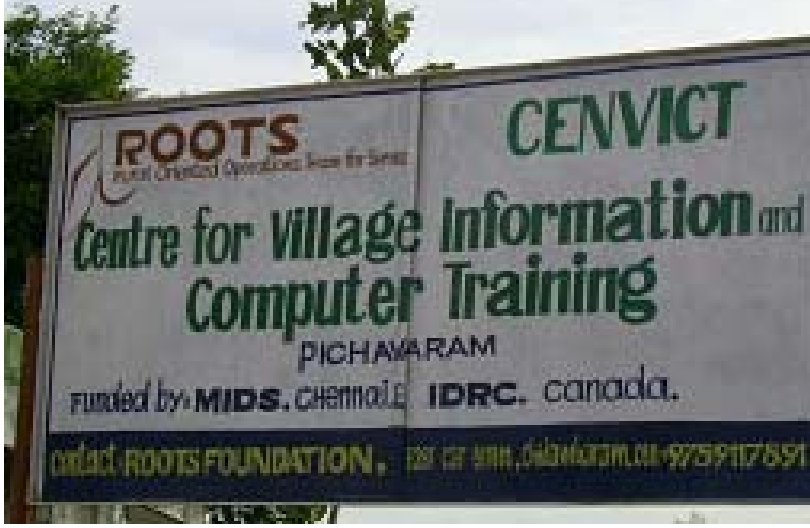


Photo: MIDS

Training centre

million are to be. By the end of next year, literally every household in Tamil Nadu will have access to a TV set. The government has also established the Arasu (State) Cable TV Corporation in order to provide cable connections to households at a subsidised cost. Every corner of the state is well covered by the cable TV network and direct-to-home service provided by Dish Net, Tata Sky, Doordarshan, AirTel and Reliance. The fact that Tamil Nadu has the greatest density of TV networks in India provides a great opportunity for disseminating early warning messages.

We have also decided to collaborate with cable TV operators so that they will broadcast weather forecasts and early warnings during natural disasters and other emergencies. The plan is that MIDS will collect information from the Indian Meteorological Department after securing permission from the District Collector and supply it both to local NGOs and to local cable TV operators for display and telecast. At the moment, we are in the process of negotiating a contract with local cable operators.

Computer literacy and information centre: Computer training for deserving youths was taken up in collaboration with a local NGO called the ROOTS Foundation based in Chidambaram. This training was implemented in Pitchavaram and TS Pettai. The preliminary vulnerability analysis and the interviews needed to select students have been conducted. In August 2008, a total of 75 candidates were selected and a memorandum of understanding signed by MIDS and the ROOTS Foundation. The Roots Foundation will contribute IRs.61,500.00 of the total cost of the programme is IRs.208,000.00 The project will contribute the balance of IRs.147,000.00 in two equal instalments. The first instalment of IRs.73,500 has already been paid and the second instalment will be paid mid-way through the training, probably in December 2008.

Coastal Gujarat

In order to implement the pilots, village-level committees were gradually formed over time as team visits, discussions and meetings followed one after the other. The members represent all vulnerable populations equally and have been a part of the process from the very first interaction. The roles and responsibilities of the committees have been clearly delineated to promote their effective functioning. The committee members learned to regularly updating the village flood status using various sources, including the media, state authorities, the Shatrunji dam site and the MIDS team. In each village, the *gram sabha* passed a resolution legitimising the formation of the committee and granting it not only institutional legitimacy within the village and representation but the right to be represented at the *taluka* and district levels.

The pilot activities identified in coastal Gujarat are summarised in Table 5.4 and described subsequently.

Livelihood diversification

Fishing and lobster rearing: Fishing is one of the most important sources of income in the coastal areas of Gujarat, particularly in Bhavnagar and Amreli districts. Utthan has initiated efforts to make this traditional occupation more profitable with its lobster-rearing and -fattening program. Since the region's rocky shores are home to spiny and rock lobsters, it has enlisted the technical support of the Coastal Salinity Prevention Cell (CSPC) to start up a small, but viable lobster-fattening programme using pit and sea cage culture techniques. Two fishing self-help groups, one each in Akthariya and Caanch Bawadiya along the Mahuva and Rajula coasts respectively, benefit. This pilot is a part of community-based coastal initiatives to strengthen local sources of employment, particularly through self-help groups and demonstrates that aquaculture can be significant income-generating activity in this region.

TABLE 5.2:
PILOT ACTIVITIES IN GUJARAT

Pilot activity	Sartanpar	Tarasara	Katpar
Formation of village-level committee and sub-committees to implement the pilot activities	Task completed and expected results achieved	Task completed and expected results achieved	Task completed and expected results achieved
Establishment of a communication system to 1) convey early warning messages to vulnerable populations like agricultural labourers, fisher-folk and outlying neighbourhoods to give them time to prepare for disaster 2) communicate information about post-disaster and development activities	Task completed and expected results achieved	Task completed and expected results achieved	Task completed and expected results achieved
Construction of earthen embankments to 1) protect houses and assets against floods 2) bring psychological relief 3) reduce the incidence of waterborne disease associated with water-logging	Construction of earthen embankment with stone pitching completed 227 households protected	Construction of earthen embankment completed 126 houses protected	Not adopted
Coastal sanitation to 1) provide access to basic sanitation to vulnerable populations, especially women, children, the disabled, and the elderly, but also men, especially during floods 2) reduce the health hazards associated with open defecation and lack of space to defecate at all	Plan to construct the sanitation unit on the earthen embankment to benefit 130 households	300 households will benefit	Sanitation unit is complete 400 households benefit
Demonstration and retrofitting of five houses in each of the village 1) to protect them from cyclones 2) reduce the loss of assets 3) reduce physical injuries caused by flying roofs 4) bring psychological relief 5) motivate other families to replicate the initiative	In progress	Two houses have been retrofitted Work is in progress in three others	Construction material has reached the village and work has begun
Plantation of salt-tolerant species (Avicenna marina (mangroves), Rhizophora, and Casuarina) to 1) protect against cyclones 2) improve the health of the ecosystem 3) reduce erosion along riverbanks	Seeds planted on five hectares and mangrove seedlings planted on one hectare	Not taken up	Activity complete; 57,000 seeds planted on 5.75 hectares
Creating and strengthening livelihood alternatives in disaster-prone areas to 1) train villagers to fatten and market lobsters, develop market linkages and use GPS to improve catches-fattening 2) train villagers to make and market ropes 1) increase understanding of the Right to Information Act (RTI) and the National Rural Employment Guarantee Act of 2006 (NREGA) 2) educate the community about disaster-specific insurance policies and products 3) provide safe portable water during disasters	Training conducted on lobster and rope-making activities RTI and NREGA understood Insurance activities taken up	Training on rope-making conducted RTI and NREGA understood activities taken up Safe drinking water activity is in progress	Training on lobster activity conducted RTI and NREGA understood Capacity built on livelihood schemes Insurance activities taken up Safe drinking water activity in progress

Demonstrations of lobster fattening were conducted at both Akthariaya and Chach Bawadiya. Because the coastline of Akthariya, which is located at the mouth of the Gulf of Kambhat in the Arabian Sea, consists of porous rocks and clay, it is most suitable for raising rock lobsters. Pit culture is the method used. The diameter of the pit depends on the site selected, and its depth is calculated so that the amount of brackish water is just right and so that there is no inlet for fresh water. A cover is necessary for promoting good maintenance and for the safety of the lobsters; it also makes feeding easier. Since the pits are subjected to both waves and gusty winds, a six-inch by six-inch moat is dug around the pits and the net is fastened down with headed nails.

Since the Caanch Bawadiya creek having an approximate size 15 km $\times$100 m $\times$ 100 m, which flows into the Arabian Sea, is constituted of seawater throughout the year, it is suitable for bamboo cage culture. In any case, the fact that the soil is clayey ruled out the possibility of pit culture. Though the creek harbours no native lobster population, the salinity of the water (35-37 parts per million) is suitable for lobsters. The banks of the creek are the suitable location for the cages because there is where tidal water seeps in for most of the year and where strong currents cannot damage the cages. During the monsoon, however, when rainfall increases availability of fresh water and salinity decreases and the cages can be shifted to sites where the concentration of salts is suitable (at 35-37ppm).

Prior to Utthan's intervention, the majority of lobsters caught along the Gujarat coat fetched low prices in the market as they weighed only around 100 grams. With the lobster fattening programme, they now weigh around 150 gm. In Katpar 32 families earned an annual income of IRs 41,500 benefiting from the programme. The programme is not without its risks, however. Salinity must be monitored regularly, particularly after heavy rains, so that it does not drop too low, increasing the mortality rate of the lobsters. It is also important to monitor the water temperature regularly and, in pit culture, to protect the lobsters from predators like snakes and fish. At the end of the project cycle, each family had earned an additional Rs.1500-2000 a month. The cost to the project was Rs.5500 one-time loan to each family plus the cost of running the training. The one-time investment cost is mainly the cost of the infrastructure; recurring costs are mostly the cost of food, which is supplied primarily from the family's daily fish catch. Both the National Centre for Sustainable Aquaculture (NCSA) and the Marine Products Export Development Authority (MPDA) have shown interest in replicating and up-scaling this activity.

Rope-making: Those who own little land get little returns from agriculture and do not engage in catching fish, showed interest in learning to make ropes. Some villagers in Katpar successfully make ropes using waste from a cotton mill. Eleven men and four women from Tarsara visited this site and were trained to make rope and make some income. Though it did provide immediate benefits to the families who participated, the long term implications need further analysis.

Capacity-building on new livelihood schemes of Government: Twenty male and 22 female members of disaster preparedness and mitigation committees in Talaja block participated in a training on the National Rural Employment Guarantee Act of 2006 (NREGA) and the Right to Information Act (RTI) in April 2008. They learned about the objectives of the NREGA, as well as about its structure of finance and implementation, registration, the importance of payment on the basis of work output, job cards, facilities to be provided in work places and insurance available. In terms of RTI, again they were informed about its objectives,

BOX 5.6
Lobster rearing

Photo: Utthan

Fattened lobster

Photo: Utthan

Collected lobster

As is true in the coastal Gujurat region as a whole, fishing is one of the main sources of livelihood in the three pilot villages. Utthan helps farmers in Bhavnagar and Amreli districts increase their incomes by rearing and fattening lobsters. In September 2007 it arranged for nine men and six women from the pilot villages to visit the fishing village of Chanchbandar in Akthariya, Mahuva Taluka, Bhavnagar District, to boost their understanding of how to rear lobsters in cages and in pits and how to market them and to demonstrate to them the sort of institutional backstopping necessary to pursue this line of work. Through their interactions with fishing families, participants learned the importance, procedure and advantages of forming self-help group and savings. They also found out about the various schemes the government of Gujarat implements for the benefit of fishing communities. The visiting farmers agreed to form their own group and to begin to work together to fatten lobsters and to raise other marine species.

but also about national and international perspectives on this right, the process for asking for information, the kind of information accessible, payment for information required, the possibility of appeal, and the penalty for not providing information. Armed with this information, the participants are in a much better position to be able to use these acts to their advantage. A follow-up meeting revealed that participants have started gathering information as one of their responsibilities. They also suggested to the *panchayat* body the kinds of employment that suited them, and requested the local body about the livelihood and income generation schemes that it could offer.

Education about disaster-specific insurance policies and products: After meeting officers from district-level insurance companies and state-level experts, the team conducted an awareness programme in August 2007 to educate the community about what insurance coverage exists, especially with regard to coverage for the risks associated with extreme climatic conditions.

Provision of safe portable water during disasters: This activity will be co-funded by the Water and Sanitation Management Organisation (WASMO). The village-level committees of Tarasara and Katpar submitted a detailed proposal for provision of drinking water to WASMO in June 2007, and resent the revised version after taking into account WASMO's comments. If it is approved, this activity will ensure that villagers have access to safe drinking water even during floods. WASMO's response is awaited.

Specific Intervention

Village-level institutional mechanisms for repairing, maintaining and constructing embankments: Steps to manage flood protection structures were piloted in Sartanpar and Tarasara. In Tarasara the worn-out structures responsible for the 2007 monsoon season overflow of the Keri River into residential areas were repaired. The coastal village of Sartanpar gets flooded with water both from the Shetrunji River and from the Gulf of Khambhat. During high tides, river water cannot enter the sea, so it inundates the surrounding area, forcing people to move to or be evacuated to safer locations. After an engineer surveyed the site and conducted a technical inspection, the village planned to construct an 325-metre-long earthen bund 3.5 m wide at the top on the right bank of the river and to cover the riverside slope with 23-cm-thick dry rubble stone pitching. To safeguard the riverbank and the new bund, it is proposed to construct two new bunds, which will, at the same time, create new silting and continue to develop even if the land is washed away. The earthen work is complete but 20% of the stone pitching remains to be done.

Sanitation: Coastal toilets are an alternative to eco-sanitation, an idea that found little support because it runs counter to socio-cultural practices and is not intended for communal usage. The structures of coastal toilets are traditionally wooden structures covered with leaves or clothes are easily destroyed during floods. If more sturdy toilets are built, they can ensure good sanitation even during floods, thereby reducing the risk of disease outbreaks, improving personal hygiene, and making life easier for women, children and the elderly. This pilot activity was initiated in areas regularly inundated by high tides and where elevated concrete structures would be necessary. The height of the structure is just above the high-flood level and it is located so that twice a day waste is washed away by the high tides. The village-level committee, with support from the project team, identified a site in Katpar where flood-affected families would benefit.

The designs prepared by the Utthan-PLC engineer with input from the community and on-site visits were shared with the communities at the village meeting. Construction in Katpar is complete, and it is about to start in Tarasara and Sartanpar.

Retrofitting of houses to protect them from disaster: In February 2008, two-days training for 13 masons from all four project villages was held in Tarasara with support from the National Centre for People's Action in Disaster Preparedness (NCPDP). Experts from NCPDP taught participants techniques for making cyclone- and earthquake- resistant buildings using theoretical and practical methods. Masons are now well trained and planned to use the methods they learned. Demonstrations of the retrofitting of ten houses are currently in process in Tarasara and Katpar. Two houses in Tarasara have been completed. In Katpar, the material required for five additional demonstrations has been sourced and work will begin shortly. All the demonstrations were carried out by the newly trained masons.

Plantation of salt-tolerant species (Avicenna marina (mangroves), Rhizophora, and Casuarina): Plantation of salt-tolerant varieties can protect the coast against cyclones, improve the health of the coastal ecosystem, and reduce soil erosion along river banks. Village *panchayats* and village-level committees agreed to provide land for the plantation and the committee retired divisional forest officer from Bhavnagar to offer his expertise in selecting appropriate locations and species. Through discussions, it emerged that it would be advisable to develop a greenbelt of *Avicenna*

marina (mangroves). Locations were chosen and arrangements about land use were made with village *panchayats*. Mangrove seeds were sown on 5.75 hectares of land in Katpar and on five hectares in Sartanpar. Also in Srtanpar, one hectare was planted with variety of *Rhizophora* and *Casuarina*.

Communication system

The communication system involved the following activities

Village information centres : SLDs made it clear that timely access to information about local weather would enable people to strengthen their flood preparedness programmes. Currently, they have access only to those meteorological forecasts broadcast on the radio, but the ability of those forecasts to predict local phenomenon was seen to be low. The villagers decided that a local-level information centre designed to gather and disseminate key information was required in each village. Village information centres are becoming an accepted model of using local wisdom and of promoting the efforts of locals to respond to floods. Neighbouring villagers have also begun making similar initiatives on their own. They used the needs they had identified to finalise the following strategies:

- Establish an information centre within each village under local leadership and supervision
- Establishing linkages between village information centres and the government departments
- Coordinate with existing CBOs and establish regular sharing dialogues
- Develop a locally appropriate early warning system
- Identify local issues suitable for advocacy campaigns through shared learning dialogues

The Public Address System (PAS) equipped with sirens and a microphone set for early warning was identified as one of the pilot activities for communication purposes. This system is kept at a common place, preferably at Panchayat Bhavan for easy access. The Village Level Committee is responsible for the use of PAS and ensures an effective and timely early warning reaches the community from the correct sources. Specific responsibilities have been assigned to members for the collection of information, verification and transmission to the community especially located at the low lying areas. The PAS includes mike set and siren. The important contact numbers like that of the Executive Magistrate (responsible for disaster information, response and relief in the *taluka*), the Engineer at the Dam site and the District Flood control room are made available to the VLC. One day orientation was also given to the VLC on how to use the equipment, effective reach of early warning to the community with necessary precautions/checks on source of information. This system began functioning in 2006.

To identify the interventions we followed a systematic approach of iterative dialogue with the community. This dialogue process kept the larger context of increased variability due to climate change in perspective. We made attempts to ascertain vulnerability in relation to specific hazards and identify options conceived as adaptation-specific interventions and underlying systems. The objective was to help reduce vulnerability. In the next chapter we draw lessons to help adapat to climate change impacts.

6

LESSONS AND INSIGHTS

We need much better understanding of the processes involved, limitation and opportunities so that adaptive strategies can be pursued at scale.

Our pilot implementation research was an important learning exercise. To avoid duplicating what has become routine—the implementation of structural activities—we proceeded carefully, choosing only those activities which would, in the long run, build resilience. Obviously, building local capacity is a long process, we did witness some positive changes and contribute to build local processes encouraging effective responses to climate change threats.

Vulnerability dimensions

The nature of vulnerability varies across the four geographical and social-cultural settings of the multi-hazard zones of our study area—coastal Gujarat, coastal Tamil Nadu, Nepal Tarai, and Eastern Uttar Pradesh. Using the lens of vulnerability to approach our study helped us to identify the key adaptation strategies adopted by each community to spread the risks of the hazard they face. In all of our case studies, we aimed to capture both the physical and social dimensions of vulnerability to disaster using, on the one hand, physical proximity to hazards and, on the other, considerations of gender, caste and access to resources. We believe that such insight into disaster-related vulnerability can be more broadly applied to vulnerability to climate and other changes, including globalisation and the shifting rural-urban divide. It serves as a way to explore adaptive strategies in general.

While the precise scale, nature, rate and impacts of climate change cannot yet be quantified, there is little doubt that stresses attributable to climate and other changes have affected life and the environment of all four studies areas. The degree, to which any individual is affected, however, varies tremendously. It depends not only on his exposure to risk, but equally on his welfare, his perception of risk and his capacity to cope or adapt. Vulnerability analysis points to the urgent need to understand the critical linkages between society and nature from many perspectives, including those of the positivist, who emphasises biophysical vulnerability; the political ecologist or economist, who emphasises social space and power relations; and the social constructivist, who emphasises people's different perceptions of reality. Such analysis is a complex, messy process with no blueprint laying out its steps. Nor is vulnerability analysis an end in itself; instead, it is an instrument to be used to foster participatory disaster planning and risk mitigation. Our study draws attention to the heterogeneity of communities at risk; to the differential, yet

intersecting dimensions of vulnerability, poverty, gender and social exclusion; and to how PVA can provide analysis of different levels in both time and space. The challenge now is to feed these local-level insights into the global discourse on climate change adaptation using shared learned dialogues. If there is no discussion, we will continue to see communities put at risk because they do not understand the potential for change embedded in any given social, political and economic reality. Integrative and comprehensive vulnerability analysis can provide the foundation for building strong, democratic and representative institutions capable of minimising disaster risk and facilitating better disaster governance at different levels. Any household, community, society or nation that can successfully deal with impacts of disaster will also be able to deal with the adverse impacts of climate and other changes.

Livelihood: In all sites, agriculture is the major source of livelihood and the majority of families are classified as "marginal farmers" because they own less than one acre of land; while the remainder are mostly small farmers whose land holding is less than 1 ha. These families work as seasonal agricultural labourers in order to make ends meet. When water-logging, poor rainfall, lack of input or pest attack affects crop productivity, farmers are forced to take loans of 10% per month in order to meet household expenses. Though agriculture is still the main source of livelihood, migration has also increased significantly in the attempt to find alternative sources of livelihood. They have found migration to be one of the most effective livelihood diversification mechanisms to cope with the adverse effects of climate hazards.

In all regions, the agriculture has grown increasingly unreliable as a source of income. In Uttar Pradesh and Nepal, paddy is the main crop in the *kharif* (July-October) season and wheat in the *rabi* (November-April) season. While these two crops are the backbone of agricultural production, monsoon flooding frequently causes water-logging so severe that the entire crop is affected adversely. With so much water-logging this phenomenon itself constitutes an emerging hazard, one which renders thousands of acres of land barren each year. Untimely rainfall during the *rabi* season has also caused severe damage to wheat.

Floods also adversely affect opportunities for daily wage labour, both on and off farms. Labourers who work in the village or in nearby urban or semi-urban areas in construction find it difficult to commute when connecting roads are inundated by floods.

Caste and gender: Gender is closely correlated with vulnerability, especially in relation to health, education, mortality, economic participation, decision-making and safety. Villages are dominated by men and elite groups; women are often not well represented politically and are neither consulted nor included in development planning processes; as a result, they can neither voice their concerns nor their ideas about how best to address them. Caste and gender norms regarding interaction constrain women's participation in community decision-making forums, instead relegating their action to separate spaces such as women's self-help groups (SHGs). Facilitating their full participation in community activities is necessary both to facilitate their empowerment but also to share information about DRR.

Diversified Livelihood

One major reason a community might be vulnerable is the lack of a diversified agricultural system and of income avenues not affected by floods. The most vulnerable group is the

landless, who are heavily dependent on agricultural labour to generate household income. Diversified farming and the production of crops adapted to disaster can reduce the impact of climate change because these strategies both improve local economies and ensure local food security.

Emu farming: In Tamil Nadu other individuals were inspired to farm emus on their own after seeing the benefits which accrued to emu farmers promoted during the study. The government officer responsible for relief and rehabilitation in Tamil Nadu was interested in this enterprise and has submitted a proposal to extend it to more farmers other than those in Pichavaram. In fact, it is likely that raising emus will be embraced by farmers in other villages as well.

The other side of migration: Over time, migration has had a significant impact in all sites as villagers see it as an important alternative to local livelihood options and a popular and convenient way of adapting to hazards. In the last several years, the search for jobs outside of villages has increased significantly. Young men would rather not reside in their places of birth or work as farmers. Though migration is clearly a coping mechanism of considerable effectiveness, it also has an adverse impact on women and children. It increases their workload, forcing them to not only engage in household activities but also to carry out farm and non-farm activities. The increased workload directly compromises their health. With men away for long periods of time, the impact of hazards is getting feminised. Another impact of extended out-migration is that the incidence of HIV/AIDS infection is increasing. In any case migration is complex issue as both pull and push factor are work, it is clear that in certain cases, climate change impact will exacerbate the push factor.

Barriers to diversification: The perceived or constructed rigidity of certain caste-based occupations, such as fishing, also hampers livelihood diversification. Despite declining fish stocks and increasing disaster risks, fishermen in the tsunami-affected coastal village of Vananagiri in Nagapattinam District, Tami Nadu, prefer not to move out of or diversify their traditional livelihood strategy. They claim, "We have no other skills; this is what our ancestors have been doing for generations and this is the only thing we know" (focus group discussion with fishing community in December 2006). While their assertion illustrates both psychological and real, skill-based barriers to occupational mobility, it also shows that livelihood intersects with identity, perhaps even a cherished identity. Such caste- or occupation-related identity can be a factor in determining levels of vulnerability.

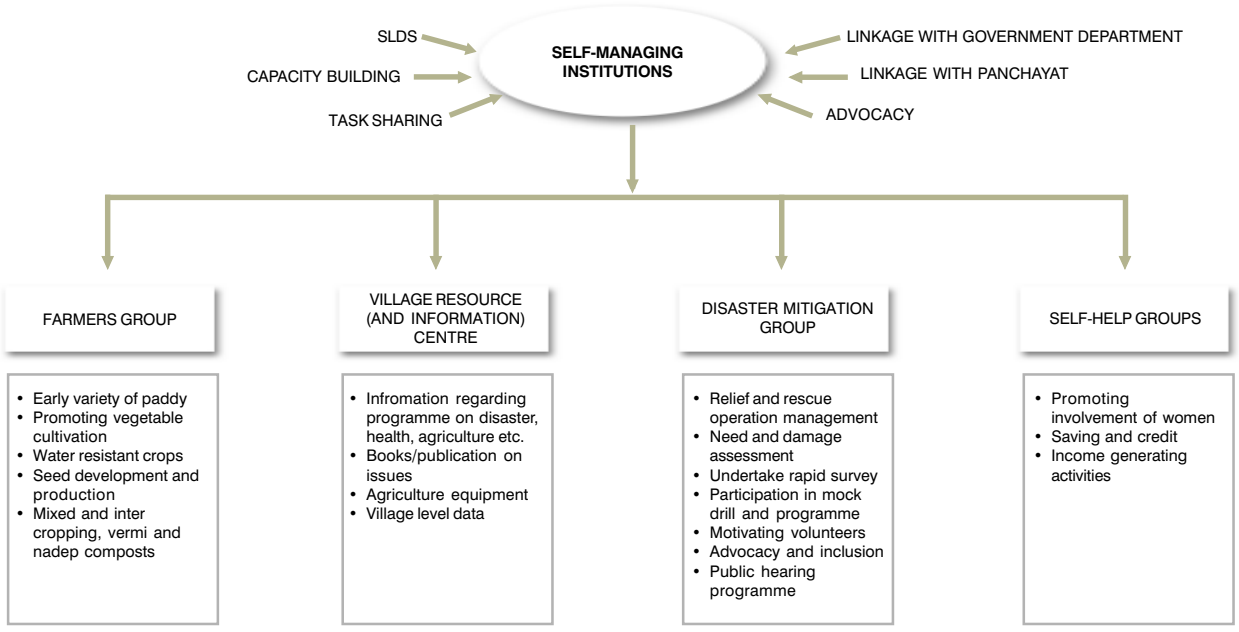
Fostering links

It is clear that local adaptation also requires building linkages with others sectors, organisations and activities. Pilots of adaptation activities must be linked with ongoing development programmes. For example, local bodies responsible for managing local natural resources can also maintain channel to let flood water drain. Local communities can advocate for support for micro issues effectively if those issues are regularly discussed and experiences shared. The management of resources becomes sustainable only if a sense of ownership is inculcated. Social support in accessing agricultural inputs and equipment like irrigation pumps can help farmers mitigate the risk of crop loss and other negative impacts associated with climate change.

Local institutions

Developing institutional mechanism for specific adaptation interventions can be one of the most

FIGURE 6.1:
LOCAL INSTITUTIONAL LINKAGES



Source: Wagih (2009)

effective ways of implementing a plan and achieving the expected outcome. Unless people have the capacity and are given the space to make decisions and to act, it will be difficult to achieve expected outcomes. Local institutions play a major role in designing and implementing adaptation plans. In all four study sites, community-based organisation with the following features played a vital role:

- Vulnerable households participate.
- Specific rules and regulations guide people in performing certain assigned tasks.
- A self-initiated decision-making process enhances people's confidence about being able to act.
- Sanctions help people to work together in a transparent and equitable fashion.
- Feedback and corrective mechanisms enable people to share learning and redesign and/or reorganise activities if required.

Food crises

A food crisis is a common consequence of a disaster as few people have food stores or savings with which to buy food. Community whose livelihoods are based on agriculture and daily wage labour often find themselves in a dire predicament not just during and immediately after a flood but for months afterward. In fact, almost five-month-long period of food deficiency is the enduring consequence of recurrent disasters. During these months, an average household of five barely manages to eat a decent meal twice a day and food stocks don't even last for half a month. The main strategy for coping with this condition is to consume less food; sometimes outright fasting is the only option for survival. In particularly adverse circumstances, people are forced to get credit from moneylenders by mortgaging their agricultural land or household assets. Both of these strategies, however, serve to perpetuate poverty. While all castes are found engaging in them, such responses are gender-differentiated, with women more likely to be denied sustenance.

Health and education

None of the sites have adequate basic services—health, education and communication— either in terms of functioning or quality even during normal times. During floods, such services are profoundly over-stretched, and people are dependent on external assistance. Health centres lack appropriate staff (there are no women doctor at the primary health care centers) and the supply of medicine is inadequate. Villagers often consult private doctors or visit a medical college in search of better treatment. Private practitioners and the staff at nursing homes have much greater credibility than staff at government institutions. The majority of children from poor families do go to primary school but after junior high school, their participation decreases dramatically because high school, intermediate- and graduate-level education is beyond the reach of villagers as the costs of traveling long distances to the nearest institution is often prohibitively expensive.

Shared learning dialogues

SLDs conducted at the village, district and state levels revealed that there are strong points of convergence with respect to the implications climate change broadly Perspectives on potential courses of action, in contrast, converged on some points and diverged on others. Where the impacts of climate change are concerned, perceptions of the threat to regions as laid out in the IPCC and other sources largely converged. The experience we gained from conducting SLDs indicated that their efficiency is contingent on the following conditions:

1. SLDs need to involve a diverse array of social groups;
2. SLDs involve iteration, a process that requires continual introduction of new information or perspectives, not just a reiteration of the same old points;
3. Often, more meetings are required at local than at higher levels, but discussions at all levels are central to shared learning.

Whereas 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 represent points of divergence in perspective. From a technical perspective, for example, the construction of regulators in deltaic areas could provide an interim protection if sea levels rise substantially. From the perspective of locals, however, this solution has the potential to be a long-term one. Structural approaches like this represent a space where perspectives diverge. Only if our understanding of such approaches is furthered we will be able to determine whether or not they can contribute to adaptation.

Where the practical logistics of SLDs were concerned, success depends heavily on organisation. District-level SLDs need to be carefully designed so that key issues which emerge from village-level SLDs are presented one by one and on time given so that dialogue is generated. For their part, village-level SLDs take time to develop as participants often rely on standard approaches that they have experienced with or have seen in other areas. It takes time and effort to get them to think beyond these approaches. Finally, for village- and district-level meetings to be able to build off each other, it is important to have a clear record of what was said, ideally by making use of a good audio-recording system.

The need for incorporating the reflexive learning processes characteristic of SLD in both DRR and climate adaptation initiatives is clear. What is equally clear, though, is that a number of key issues, many of which are central to most

strategies for participatory development, also must be addressed if the attempt to develop and implement such processes, primarily through SLD, is to be a success. These issues include the following.

1. *Adopting a balanced approach*: Analysts tend to focus either 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 a sensitive balancing act.
2. *Building dialogue capacities:* It was difficult to identify, the knowledge and perception of various stakeholders. They brought with them certain deeply-rooted conventional perspectives and understanding but did not come out in the dialogue process. This required many sittings. In addition, even the personnel from the research organisation who participated in this process had as much difficulty understanding the implications of climate change and hazards as local communities did. If they are to be able to guide the dialogue process, they must demonstrate the right attitude toward the endeavour, a willingness to learn, and technical familiarity with the issues involved. Though many socially-focused development processes downplay the role of technical knowledge, in the case of addressing the risks and the implications of climate change, familiarity with technical concepts is essential.
3. *Developing mechanisms for deriving lessons:* We need to develop systematic processes for capitalizing on the key learning points which can be derived from the exchange of knowledge and for documenting how perspectives on strategies for responding to hazards and climate change evolve across scales. It will be a challenge to ensure that actors at different levels do not filter out or ignore insights from other levels. In our study, for example, we noticed that the contents of field notes from SLD meetings were often not reflected in the write-ups produced by the individuals in charge of guiding the process. Because the recording, transcription and qualitative analysis of dialogues are so time-consuming, it may not be replicable in many programme contexts.
4. *Managing the chain of learning across scales:* The issues of capacity and mechanisms from learning discussed above greatly complicate the management of learning across scales. The reflexive learning objective central to the SLD process needs to be clearly understood by every link in the full chain of actors involved in research and programme development, right from the very local level up to the state or national policy level. In many cases, however, core elements of meaning are difficult to translate across scales. To address this hurdle, it will be important to train facilitators to work at multiple scales and thereby to bridge the gap.
5. *Ensuring the process is accessible to key groups:* As with many social dialogue or stakeholder processes, access to SLD can be affected by gender, class or other considerations. It will be important to identify and to overcome any potential or existing barriers to full participation.
6. *Clarifying the objectives of the process:* Researchers involved in SLD processes often view them as mechanisms for collecting data on capacities, vulnerabilities, livelihoods or other community characteristics rather than as a means of accomplishing reflexive learning, their true objective. While information on

such characteristics can and does arise out of SLD processes, they should not be seen as an end in themselves. At the study location villagers also misinterpret the goal of SLDs, seeing them narrowly as part of project planning or research. SLD is not a one-off occurrence; they must be regularly repeated in order to observe the evolution of understanding which will occur at all levels as they incorporate new information and perspectives and thereby build their resilience to hazards due to climate and other changes.

Communication systems

As part of communication systems development activities, available modes of communications were identified, strengthened and promoted. Making important telephone numbers such as police, army, district administration, government departments, local organizations, local leaders, social workers, available to the volunteers to be used at times of crisis is primary level information sharing mechanism. Community managed Radio stations (FM) form part of the communication strategy to provide information on early warning and cyclone and flood forecasting. Similarly, radios programmes production would be self-managed by the community groups to provide information on mitigation measures and approaches that communities can adapt. Mobile network penetration provides opportunity for providing early warning and forecasting information through text messages (SMS) and alert systems.

Local methods of communication such as public announcement using hawkers, door to door visit by volunteers, distribution of pictorial pamphlets, puppet shows, and awareness building TV programmes are part of local level communication mechanism to enhanced information access and help in preparedness.

Hospital workers, transport workers, bankers, and other service providers are part of emerging adaptation approach as their services at normal times can help people prepare for eventualities (for example, simple procedures in collecting remittance). One of the most important research objectives had been assessing barriers to communications, identifying the audiences and how do they access information, how can we work to address barriers, how do we penetrate into it and yet ensure its affordability, for example smart card, banking knowledge, and so on.

The development of physical capabilities of communications that enable communities to adapt to floods and droughts is crucial to social resilience. This includes, for example, improved communication infrastructure such as local FM stations and access to cell phones that can be used to provide advance warning of extreme events while also providing the access to information on job opportunities, market conditions, etc. that enables households to diversify income strategies or otherwise adapt. It is also likely to include key physical infrastructure that enables communities to access markets and vice versa. This includes enhancing networking with local FM stations, mobile phone service providers and other news/ communications media along with weather information.

Ecosystems

All the project areas are impacted in one or more manifestations of hydro-climatological hazards (floods, droughts, cyclones, etc.) and increased climate variability. These hazards, in conjunction with pollution and ecosystem mismanagement, have led to degradation of these already fragile ecosystems. Considering the limited capacity of ecosystems to sustain the provisioning of goods and services if they are being degraded,

the adaptation options identified can be broadly conceived as the following:

a) Promoting measures to revive ecosystem services through activities such as large-scale plantation of mangrove and forest buffers
b) Altering the system to *fit* with the current level of ecosystem services, for example, shifting to early maturing varieties of paddy or promoting higher flood-resistant and/or salt tolerant crop varieties.
c) Promoting interventions that consider the opportunities emerging due to climate change by altering the fundamental systems on which livelihoods are based. In one specific example, in coastal areas of Saurashtra, lobster fattening was considered to be more efficient and resilient than trying to work on reviving the severely degraded agro-ecosystem to its prior state.
d) In all the project areas, non-farm interventions were considered worth implementing as a means to bridge livelihood and income deficit at household levels.

Overall, the above menu of strategies has yielded encouraging results with regard to building community resilience and adaptive capacity in the face of increased climate variability and uncertainty. These pilot interventions need to be taken forward through enabling sustainable, systemic environmental policies and also by ensuring their proper and effective implementation. Individuals and communities are already pursuing autonomous strategies to respond to emerging constraints using the information and resources they have at hand. Sometimes, however, such actions are maladaptive because they are based on limited understanding and access to information and/or resources. Significant capacity building efforts are needed, both on the part of policy making and organisations that work with local communities, to support and encourage behaviour that are not maladaptive.

In the context of climate change, with increased variability and uncertainty, it becomes imperative to promote a process of adaptive learning involving actors from all levels, the villages on up to the national government. The learning must feed into formulating of policies and in its proper implementation. SLDs also aid in creating the necessary awareness and capacity building at various levels. This said, it must however be emphasised that the policy terrain does not just involve the government but, also market and civic movements. Each represents a particular worldview, define the problem differently and perceive solutions differently. Each responds to different incentives. In the process each formulates its own policy and hopes to influence the behaviors and actions of other groups.

Attitudinal and behavioral changes: Outcome mapping

In all study sites villagers are aware that the climate patterns are changing. They recognize that it has become erratic and that these changes make them more vulnerable to climate hazards. Yet we found that they took both autonomous and planned measures to cope with the impacts. Small landholders, for example, diversify from agriculture when they realise that the benefits of taking such a step can be long term. They recognize that they must work closely with local government units. The participation of district and the block level government officials in village-level pilot projects can add legitimacy as villagers perceive that the formal systems have endorsed their efforts.

The research shows that shared learning process can engender behavior changes to

respond to climate change impacts. Ultimately adaptation is about changing behavior in response to new constraints because conventional approach will not work. Adaptation is also about generating new knowledge, which however does not come about automatically but is part of a continuum of discrete data-information-knowledge-wisdom (Sardar, 1996). By implementing a set of activity we generated data which when assimilated becomes information to be synthesised into knowledge. Tested knowledge overtime then can become wisdom. This outcome is not a linear and one way street but an iterative process where falling back must always be accepted as natural.

As researcher what tools does one use to assess this behavior change process? We selected outcome mapping (OM) as a method. OM is a recently developed tool that focuses on the outcomes rather than the impacts of development by indicating what a project wants to accomplish, with whom, and how. It is a shift from assessing the development impact of a programme to assessing changes in behaviours, relationships, actions or activities and focuses on specific changes in the behaviours of the communities, government agencies and organisations with which a programme works directly. It provides a basis for looking regularly at how it can improve its performance and evaluates the project as a whole at the end. OM helps to paint a picture of the outcomes of a project and provide clarity in evaluation (Sarah, et. al., 2001).

It was difficult to use the tool as a core methodology because of the pace of change itself. Key actors who work in the field of climate change adaptation issues kept shifting and new ones are emerging quickly. As a result, targeting and tracking the evolution of relationships and thinking within a fixed set of boundary partners proved difficult on a practical level. Targets are not shifting gradually; they are leapfrogging. Project partners tracked progress only inconsistently, though a few did manage to keep their outcome journals up-to-date. The difference in the individual behaviour of staff members was complicated by the fact that the context in which all work is a dynamic one whose changes are difficult to keep up with. Resolving its limitations as a methodology (or addressing the behavioural limitations of project personnel) will require careful consideration for assessing project outcomes. Outcome mapping needs to be tailored to better respond to the dynamism characteristic of debates over adaptation to climate change.

FIGURE 6.2:
DATA–WISDOM CONTINUUM

RELOCATING THE STUDY FINDINGS IN THE LARGER DISCOURSE

The study lessons contribute to theory and practices.

Most of the population of South Asia depends for their livelihoods on farming, an occupation dependent on timely and reliable access to water. Access to good irrigation facilities both helps increase yields in normal times and reduces the risks of loss due to climatic vagaries like drought and extreme precipitation events. Access to a nearby source of water has other benefits: since it reduces the time spent in collecting drinking water, it frees up leisure time. It is fundamental to improving sanitation and hygiene. Unfortunately, the established link between water and human development has come under increasing threat as a result of two interlinked processes: technological and economic globalisation. Since both processes, which are dependent on the prevailing fossil-fuel based energy platform, result in the continued pumping of greenhouse gases into the atmosphere, they contribute directly to global climate change. Climate change, for its part, is making precipitation erratic with increasing instances of floods and drought. Both exert pressure on food security. The fact that globalisation has shifted the pattern of dependency on food systems from the local to the global scale also serves to exacerbate the stress.

Many past and recent researches suggest that because of climate change, temperatures will rise and the precipitation will grow more unpredictable. The impact on food systems and food security will be drastic. Lessons based on climate change scenario suggest that the net cereal production in South Asian countries will decline. In fact, 2004 study conducted by the International Rice Research Institute showed that the decline will be as much as 10% of the yield of rice for every 1°C rise in the minimum temperature during the growing season (Peng *et al*, 2004). That climate change make condition stressful is clear but how the linkages play out is poorly understood because linkages affect not just food production but hamper its equitable distribution with long-term socio-economic implications. Erratic weather has affected crops on several occasions in many parts of Nepal in the last four years for example. One factor is the consequence of climate change. Food prices have increased. According to WFP over the last three years, the number of people it helps has almost tripled, from 1.2 million to 3.4 million in Nepal (MoAC, 2009). At present, 40 districts, mostly in the west of the country, face major food deficits and the World Food Programme (WFP) anticipates delivering almost four

times the food aid required compared to prior years and food security is in serious jeopardy. In the future farmers will face even greater agricultural stresses and it is perceivable that an unplanned wave of 'climate migration' could occur within the next 10 years (WFP, 2009).

The reasons are interlinked but complex. Long-term investment in agriculture collapsed during Nepal's decade long insurgency has yet to recover. Twinned with the poor development outcome is that malnutrition is rampant with profound impacts. In the country's districts in remote hills, the rate of chronic malnourishment among children under five reaches 60%. In the longer term, this appalling figure coupled with a crumbling state education system in a political transition implies huge cost to Nepal. The country faces a future of rising population, high outmigration, climate change impacts in a political instability, with many of its children disabled by malnourishment. The conventional development approach does not lead to creation of new livelihood.

What do the above facts imply in practical terms, as we aim to develop a better understanding of the adaptation measures people adopt in response to stresses such as but not limited to those caused by climate change? Our study suggests that if a system is adaptable, those who depend on it should do well, even in changing conditions. People can do well either because they can actively shift their livelihood strategies to respond to emerging constraints or because the systems on which their livelihoods are based themselves are resilient and flexible enough to absorb the impact of changes. The ability to switch strategies in the face of constraints is central to adaptation. Our study has identified eight central issues that require further exploration in our attempt to better understand how populations adapt to the impacts of climate change.

- Adaptation and development;
- Autonomous and planned adaptation;
- Livelihood diversification;
- Adaptation and energy;
- Institutions;
- DRR;
- Policy;
- Knowledge systems; and
- Support systems.

Development and adaptation: For many developing countries including those in South Asia it is necessary to distinguish between development and adaptation. Exploring the linkage Huq and Reid (2009) argue that adaptation to climate change is linked fundamentally to development both for the developed and developing countries because both will be adversely affected by climate change. For developing countries however, climate change implies a double slap. First it stresses the ongoing journey in attaining well-being in its entire dimension including economic sufficiency, social equity, personal security, good health, freedom and identity. In many countries and societies, some of the basic needs contributing to well-being such as clean drinking water, basic sanitation, health, energy security and education are still not available to majority of the population. This deficit in development is intertwined with deficit in governance. All sorts of political and administrative factors, including poor governance, low fungibility, weak institutional capacity and memory, poor technical and technological capacities, excessive dependence on donors, lack of coordination, vertical-structuring of agencies, centralisation and politicisation keep countries such as Nepal on the path of low-level development (NCVST, 2009).

For countries like Nepal, which depend heavily on overseas development assistance funding to

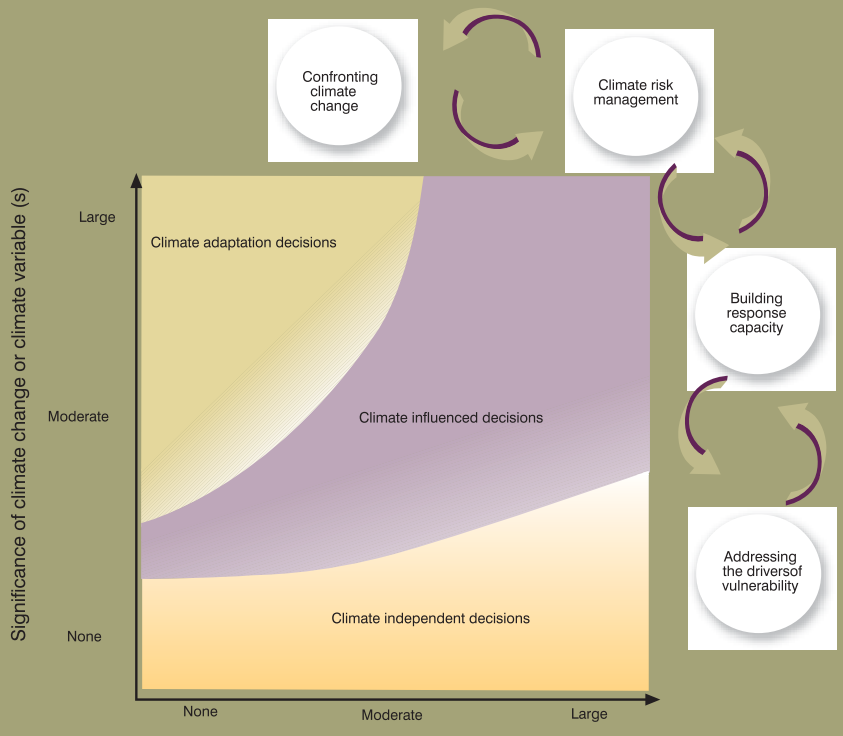
BOX 7.1
Adaptation development continuum

UKCIP has developed a two-by-two matrix with the significance of climate change as the Y axis and the significance of non-climate factors as the X axis. The matrix conceptualizes three decision-making domains: climate-adaptation decisions, climate-influenced decisions and climate-independent decisions. Though the boundaries between them are not precisely defined, the matrix is helpful as a decision-making tool and can be enhanced by overlaying an additional conceptual approach, one which helps differentiate between development and adaptation. This latter method conceives of development and adaptation as a continuum consisting of four tasks: addressing the drivers of vulnerability, building response capacity, managing climate risk and confronting climate change (McGray et al, 2007), but more effort is needed to clarify the differences. Unfortunately, the uncertainty associated with projections of climate change renders making such a differentiation a daunting task. The case of the Himalaya, where scenarios for monsoon rainfall projected by various global circulation models in 2009 varied from a 52 percent reduction to 135 percent increase, is illustrative.

Given the difficulties associated with developing a precise picture of the future—the limited availability of data, our poor understanding of monsoon dynamics in the Himalaya, and the complexity of the topographic characteristic of the region—developing a more robust scenario may be an unachievable goal. The uncertainty of the future scenario, however, should not be construed to mean that there will no vulnerability and that adaptation will not be needed (NCVST, 2009). Our inability to differentiate the link between adaptation and development remains key constraints in our endeavour to make decision as the future becomes uncertain due to climate change. To overcome this limitation, McGray et al. (2007) suggests that a broader and more nuanced definition of adaptation is needed to accommodate the complex relationship between adaptation and development.

Confronting climate change	Climate risk management	Building response capacity	Addressing the drivers of vulnerability
Focusing almost exclusively on climate change impacts, typically targeting climate risks that are outside historic climate variability, e.g. tackling sea level rise or glacial lake floods.	Integrating climate information into decision to reduce negative effects on resources and livelihoods, e.g. disaster management, drought resistant crops, 'climate-proofing' infrastructure.	Building robust systems for problem solving for both climate and non-climate related activities, e.g. communications and planning processes, weather monitoring and natural resource management practices.	Improving fundamental factors to reduce vulnerability to poverty and harm, with limited direct attention to climate factors, e.g. health, education, women's rights, accountability

Source: McGray et al. (2007)



Graph adapted from Willows and Connel (eds. 2003)

meet their basic development needs, securing additional funds for climate change adaptation is yet another challenge, one which Bapna and Macgray (2009) contend emerges from the "impossibility of disentangling adaptation from development complicating efforts to even estimate adaptation costs" (Bapna and Macgray, 2009). Yet, it is necessary to address both conceptual and methodological challenges. Conceptually, we need to differentiate between normal developments pathways from the additional stress imposed by climate change. Secondly, we need appropriate method to allocate that additional fund to reach where it would be needed.

Autonomous and planned adaptation: At the conceptual level, adaptation can be differentiated as autonomous and planned as we explained earlier. This differentiation between planned and autonomous adaptation also raises a new set of questions about the nature of adaptation processes at different scales—individual, household, community and national. The former occurs at the level of individuals, households and organisations as people respond to different kinds of stresses, including those which climate change introduces. Planned adaptation, in contrast, occurs at the societal and at the level of the state. Planned adaptation can be predicated to achieve the goal of proactively identifying and responding to the constraints climate change imposes. To plan adaptation requires impacts to be directly attributable to climate change but this is not possible in many cases. The available scientific methods do not yield précise climate change scenario particularly in relation to changes in rainfall patterns. Yet we need to deploy methods to minimise uncertainty where possible. This is one aspect of planned adaptation. Secondly planned adaptation can help developing infrastructures and support systems which are resilient in the face of climate change impacts and which help individuals, households and communities switch strategies, or, in other words, facilitate autonomous adaptation. This is what we conceive of systemic approach. Our study underscores the need for investigations in understanding on parameters of both approaches.

Livelihood diversification: Many studies, including our own, suggest that increasing the number of opportunities to diversify livelihood can make an individual and a family more resilient to stresses, including those induced by climate change. Adaptive capacity, or the ability to switch strategies as conditions change, can be enhanced by diversifying livelihood. Our study, for example, has shown that a family with varied sources of income is better cushioned against disasters like flood and drought. In all the case study sites, one of those sources is remittances from a household migrant. In addition, many families have turned to income sources other than the traditional, agriculture-related ones. Many rural emigrants end up in cities seeking blue collar jobs in the transportation, construction, industry or service sectors. For those involved in climate-dependent livelihoods such as agriculture and fishery, finding employment outside this sector is the most fruitful opportunity.

Adaptation and energy: Our study did not set out to investigate the linkage between adaptation strategies and access energy or its security, yet as we progressed, it became increasingly clear both are intrinsically linked. Some adaptive approaches, particularly those involving a switch out of traditional livelihood such as agriculture or natural resource systems, clearly are dependent on access to and the availability of affordable and reliable. For farming families facing the stress flood and drought caused by erratic rainfall, opportunities for diversification include the industry, construction

and service (banking, insurance, media and communication, transport, education) sectors, all of which depend on access to reliable and affordable energy. The larger context of climate change means that we need to develop energy systems with a low carbon footprint. We need to investigate both how energy increases adaptive scope as well as which source combination will best meet future needs without falling into the pitfalls of the current fossil fuel based system.

Institutions: There is a disjunction between the stated policies, the roles organisations play and the actual support that victims of disasters receive in the aftermath. Conventional responses to disaster conceive of relationships among social, economic, administrative, cultural, legal, and technological environments in a linear and mechanistic sense when, in reality, they are complex because of the dynamic influence that knowledge, resource bases and social organisations have on those environments. An appreciation of this complexity leads to the necessity of seeing institutions as distinct from organisations.[1] Institutions, unlike organisations, are dynamic: they exhibit a pattern of values and behaviour within a social system and their functioning is sustained over a period of time because they respond to changes in the environment. In other words, human institutions and the contexts they are set interact with and influence each other through feedback loops over time.[2] As a sub-set of an institution, an organisation is a physical manifestation of the rules and procedures established *a*-prior by the institution it belongs to.

Formal institutions, like the DoI, have codified rules and procedures, while informal institutions, like farmer-managed irrigation systems, have generally accepted but not codified rules and procedures. The institutions of families, user groups, cooperatives, banks and trade unions mediate the access of the poor to assets, technologies, credits, seeds, insurance, health care and markets. Rules (laws, customs and administrative practices)—the organisational aspect of institutions—determine whether the poor in general and those affected by disasters in particular benefit from improved access to services.

By conceiving institutions in this broad sense, we can better understand the social dynamics that underlie adaptive responses to climate change. This is because institutions, in their dynamism, facilitate the process of helping communities and families affected by the impacts of climate change adjust by fostering both reliance on internal societal supports and the ability to negotiate with external support organisations or the market. The success of communities in adapting depends on how well they collectively exercise civil power, a capability that depends on their access to information and knowledge, especially about what alternative courses of actions are available to them, as well as on how best they can use those courses. Access to information is crucial, but that information must be made usable if communities are to be able to capitalise on it; otherwise, it is as good as being unavailable altogether.

Also information is not neutral and we must recognise that they can contain political overtones. Yet if and when available, information can be used as a text for negotiation. Since building self-reliance and the power to negotiate is time-consuming and difficult, it cannot be expected that responding to climate

[1] This approach to institutional study acknowledges the interrelationship among knowledge, values, social organisation, technology and the natural resource base. For a detailed discussion, see Gyawali, *et al.* (1993)

[2] Pelling (2003) refers to the concept of co-evolution by Norgard (1994) while discussing paradigms of risk in natural disaster discourse.

change effectively will be any easier. Even responses to ordinary floods and droughts, not those whose effects are magnified by climate change, have not been effective. In the past poor families affected by disasters have been left to fend for themselves in the aftermath of such events. Only if their institutional capacity to adapt is increased, the families will be able to recover on their own and move on in the well-being ladder.

DRR: Cost and benefits*:* Our findings corroborate the conclusion of much contemporary research that DRR, on the basis of a cost-benefit analysis, should constitute a core element of adapting to climate change impacts. However, the case studies also indicate that not all forms of DRR are good investments. They also indicate that attention needs to be given to the manner in which cost-benefit analyses are framed and conducted: if they are neither transparent nor highly participatory, their results can be misleading.

The results of qualitative and quantitative analyses, experiences in the region, and generation of climatic change scenario all suggest that much more attention needs to be paid to the consequences of inter-and intra-annual climatic variability and to strategies for reducing the related risks. At present, most attention is paid to high-profile extreme events that generate major disasters. While responding to such events is important, recurrent small events have the potential to generate large aggregate economic impacts. Smaller events may be of particular importance to the ability of populations to rise above poverty and adapt to climate change. For this reason, low unit cost, distributed approaches to risk reduction that respond to recurrent events often may be more economically and socially effective than large investments only in structural flood control measures such as embankments which are targeted toward low-frequency but high-magnitude events. Our results cannot conclusively suggest that recurrent disasters should be the focus, but they do suggest that this enquiry is one area where additional research could provide critical guidance to effective policy making.

Another critical area requiring additional evaluation is the costs and benefits of various approaches involving a blend of financial, distributed and carefully-targeted interventions designed to share and reduce risk. Such approach may generate substantially more benefits than any single approach could on its own. The relevance of cost-benefit analysis as a tool to support decisions is dependent on the processes and methods used. For results to be robust under different conditions and different sets of assumptions, it is necessary to use processes that utilise both qualitative and quantitative methodologies assuring that the assumptions and limitation are transparent, not a black box. More specifically, analysis clearly demonstrated that distributed interventions which deliver annually benefits with low initial costs are less sensitive to discount rates under variety of climate change scenarios. Centralised and large scale interventions are climate dependent. An embankment is a clear case. Cost-benefit analysis, if the method is to serve as a major tool for supporting decision-making, must be combined with qualitative processes of analysis.

Because data and data sources, assumptions, and externalities—and how these inputs were identified--have such a considerable impact on the results of a cost-benefit analysis, they must be made transparent. Transparency enables stakeholders to better evaluate the validity of the results and/or come to their own conclusions. In addition, it is important to use the same or at least comparable frameworks and methods to evaluate different types of

interventions in order to facilitate making a choice on equal grounds. Transparency is particularly important in presenting the results of sensitivity analysis and in presenting the implications of various benefit-cost ratios. It is also required in order to identify those factors that have the largest impact on whether or not investments in risk reduction do indeed deliver robust returns under the wide array of possible climate and other conditions likely to occur in the future.

Cost-benefit analysis has the potential to become a useful tool for decision-makers seeking to evaluate different strategies for responding to disasters and reducing the impact of climate change. Particularly in highly centralised policy environments such as those found in South Asia, participatory processes for conducting cost-benefit analysis could, by highlighting the often high returns associated with small-scale, distributed community interventions, should contribute to shift in our approach to risk reduction. If cost-benefit analysis is to evolve from a "special purpose" technique for the one-off evaluation of DRR projects into a major decision-making support tool, its methodologies and processes must undergo substantial improvement.

Policy: Despite its espousal of bottom-up approaches including community participation in meeting objectives like reducing the risks of disasters, the actual policy context is centralised. In most cases, actual participation is limited. Initiatives to reduce risk, particularly when implemented in response to specific events, are often influenced by populist or other considerations rather than by their true role in risk reduction. In addition, the current policy environment limits shared learning because there is no discussion or feedback mechanism. Often policy is singular: it is the view of the government and the government alone. We need a shift in our understanding of what policy constitutes: it should be based on recognition that social groups are guided by different incentives that espouse different value and pursue different strategies giving plural voices in the policy terrain. All voices must be engaged in a healthy interchange of ideas.

Knowledge systems: The need for improving understanding and awareness of climate change and its potential impacts is central, as is the need to create a mechanism to discuss how strategies can be made adaptive to climate change impacts. All our case studies suggest that the question of how mechanisms that govern the flow of information about climate and weather, agriculture and new technologies and practices can be institutionalised must be addressed. In many places, we found that not even information available in the public domain is available in a form that local users can understand as and when it is needed.

Both rational and indigenous knowledge systems must be brought into synergy. Nowhere is this more critical than in water resource engineering. Designing specific measures in water resource planning requires having measured data on hydrological and natural processes; using this data historically collected as a foundation, probabilistic methods are used to conduct analyses and make inferences. However, as the future grows increasingly uncertain due to climate change, it is unlikely that historical data will continue to be able to predict future conditions. Indigenous knowledge also has limitations. One example of a traditional knowledge that has changed, for example, is the belief that the day in August when Lord Krishna was born will see heavy rainfall. In last few year people reported that this day has seen no rainfall at all. While such approach is able to report on what is happening on a day-to-day basis on the ground, it is

embedded in oral history and has little sense of either long-term or regional processes. We need a better way of amalgamation of the strengths of each knowledge system and scientific knowledge.

To improve the precision of global climate models, major investments in research and other activities are currently being made. However, given the uncertainties inherent in the modelling process and in the data on which they are based (developing countries, in particularly, suffer from insufficient and limited datasets), these investments are unlikely to yield any more reliable probabilistic information regarding basic hydrologic parameters. As a result of the lack of predictability, the viability of conventional strategies for designing water resource infrastructures, insurance systems and institutions for water management like flood zoning will be severely challenged. Instead, we must develop knowledge systems on which to base institutional and infrastructure designs that do not require probabilistic information on future conditions because historical data does not help predict the future as climate change proceeds. In other words these predictions must be interpreted cautiously and where possible, ground-truthing with local knowledge systems thus abandoning our bias towards one or the other.

Support systems: Our study revealed how crucial systems are in enabling adaptation and corroborated our earlier research (Moench and Dixit, 2004, eds) on responses to floods and droughts which identifies a variety of systemic factors that contribute to livelihood resilience and adaptive capacity. Adaptive capacity and livelihood resilience depend on the following systems:

1 *Knowledge* – the basic education required to access multiple job and skill markets along with other forms of memory and learning;
2 *Environmental* – the condition of basic land, water and air resources along with the productive ecosystems they support;
3 *Livelihood and economic* – 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* – the ability of information to flow in and out of areas, including both the technology itself and the institutions and rules governing that flow;
5 *Transport* – the ability of goods, people and resources to flow in and out of areas;
6 *Financial* – the ability of funds to flow in and out of areas and for assets to be converted as required;
7 *Organisational* – the ability to self-organise following disruptions as well as during more linear and controlled phases of change processes; and
8 *Adapted infrastructure* – the degree to which physical and institutional structures are designed to accommodate and respond flexibly to climatic variability and change, including extreme events.

Conclusions

Making adaptation work broadly and for vulnerable people specifically will require our developing much deeper understanding of the contexts, efforts, resources and appropriate institutions that can be brought to bear in this effort, especially given the fact that the climate is changing rapidly than anticipated. Getting adaptation right will also depend upon being responsive to local conditions, including local climates, markets and socio-economic

conditions. The socio-economy is especially important because in many areas the relationship between urban and rural lives is changing. DST (2008) characterises this change thus: "these regions are linked to major urban centres by cheap transport axes where much more intense commercial agricultural and non-agricultural economic activities take place than in purely rural areas." The process of change involves closely interlinked and co-penetrating rural/urban livelihood, communication, transport and economic systems. The characteristics of this emergent mixed economy have fundamentally changed the context in which formal and informal institutions for environmental management and service delivery first evolved, often rendering them defunct or undermining their effectiveness. In many cases the new economy has fundamentally changed the proximate relationship between livelihoods and ecosystems: where populations were once dependent on locally produced food, now prices and access are determined by global markets and conditions in distant ecosystems (DST, 2008).

While many countries and regions are characterised by a dynamically changing social and political landscape, no two landscapes and the dependent society are the same. Taking unique local conditions into consideration in the conception of adaptation measures at various levels or in the delivery of services requires having an adequate information base, appropriate institutional mechanisms and significant social and technical know-how; if local factors are ignored, the adaptation strategies derived are unlikely to work for those who face the gravest risks. As national governments and their partners plan how to respond to the changing climate, they must take into account the likelihood that adaptation measures will need to be continuously adjusted over time as conditions change and new constraints emerge.

The intensity and pattern of changes has far-reaching implications for surface-atmosphere interactions. In particular, they could significantly accelerate biome shifts and magnify the impacts on water-related ecosystem services both within and between biomes as well as across spatial scales as wide as South Asia as a whole. Their impact is so drastic because changes in land use and intensity and in the quality and amount of water resources alter all key environmental processes at the catchment level. These effects then cascade from catchments to floodplains to river channels and severely impact the functioning of water-related ecosystems and the services dependent on them. Water-related ecosystems suffer particularly much because they are subject to a host of pressures from a combination of agricultural, local non-farm and urban demands. Fundamental changes in land use, the increasing demand for water and increasing pollution from all sectors make matters worse (DST, 2008).

The rate at which institutions adapt often lags behind the rate of physical change in ecosystems. In dynamic conditions and as pressure on ecosystems increase, the reliance on existing formal and informal resource management institutions become increasingly less. Another reasons traditional formal institutions decline is that people's activities and products have become increasingly mobile and separated from local ecosystems. As a result, the market has opportunistically stepped in to meet the institutional gap in the provisioning of ecosystem services; the emergence of local water markets are one example of this shift. The emergence of market can be unfortunate and debilitating for the poor who cannot afford to purchase the services that

they once received for free from the common or at very low cost. The question of the increasing dependence of local populations on services produced by distant ecosystems and its impact on adaptation must be tackled. Improving our understanding of heterogeneity, thresholds and tipping points within interconnected ecological, economic and social systems represents a fundamental challenge as we aim to understand how to adapt to impacts of global climate change.[3]

Research is required to identify and develop pro-poor and effective institutions which will be able to manage ecosystems and the flow of ecosystem goods and services at the local level even in the context of increasing climate variability and economic globalisation. Basic research is also required to understand changes in ecosystems and their implications for human wellbeing, including health, food security, physical security and socio-economies. Particularly critical are questions involving the resilience of regional hydro-ecological systems and how they will respond to the complex dynamics of mixed, patchy land use, mixed livelihoods and variable precipitation. The critical management question is what local and river basin-scale strategies will maintain balanced land-use mosaics, surface and groundwater systems, and river-floodplain connectivity in ways that sustain critical ecosystem functions.

This, however, is easier said than done as the following example illustrates. In a detailed analysis of a small river system Tinau in Nepal Gyawali and Dixit (1999) found high interdependence surface and groundwater systems, and water use patterns but poor institutional linkages. Water diversion and presence of irrigation systems influence flow dynamics throughout the river's lower reaches. Return flow from irrigation and municipal systems influence downstream water quality. Embankment construction in one area exacerbates flood problem in other areas. Widespread use of private pumps through shallow wells by farmers influences government irrigation plans. Extraction of sand and boulders from river bed and selling them in nearly by towns earlier used to be source of livelihood of the poor and migrants. Now Nepal's District Development Committees (DDCs) award licences to extract these raw materials in large scale and export to India. While it generates some revenue to the local government's coffers, the losses to ecosystems is high.[4] Such interactions are relatively easy to conceptualise but extremely hard to quantify because there is no data available about surface water, groundwater or their interaction or their uses.

Given the extent of complexity the way forward, however, is neither simple, not straightforward. The problem is difficult to define, and when an attempt is made to do so underlying layers which appear even more intractable and complex, emerge. Solutions to such enmeshed problems cannot emerge from conventional approaches and we need to seek them in the larger dynamic context encompassing change and development. Changes do not happen serendipitously or neatly but may reach pleasant or unpleasant ends with several mixes in between that are difficult to foresee (Thompson, 2008). Development is no different. According to Salomon (1997) "Whatever its pace and level, development is a journey between tradition and modernity. In this

[3] For detailed discussions on the linkages among ecosystems, poverty and climate change see DST (2008)

[4] On 4th January 2010, Nepal's Parliamentary Panel on natural resources directed the Government of Nepal (GoN) to immediately stop export of stones and sands.

dynamic process, quantitative indicators are always relative: development never stops and certainly is never achieved once and for all, nor can progress be measured merely in quantitative terms." He goes on to argue that "The journey of development takes time, incurs costs, requires choices to be made, and therefore, demands a resolute collective determination not simply to cope with the risks arising from change, but to try in a long-term perspective to guide change in a particular direction."

The uncertainties associated with global climate change are serious fault lines in the human journey for development and change. The journey to modernity from tradition was technologically locked in the political-economy of availability and burning of cheap fossil-fuel. While the pathway enabled western civilisations to reach high level of development conceived in the conventional sense, the byproduct of this pathway has been accumulation of anthropogenic green house gases in global atmosphere and climate change. The unintended consequence of excess green house gases has been erratic hydrological system; frequent droughts and floods, habitat, ecosystems and livelihood loss and so on. Clearly anthropogenic climate change imposes new stress layers on societies that aim to catch up in development. In that journey, today human civilisation stands in a fork. The question is, do we continue in the conventional emission-ridden pathway or devise an alternative one. Conceptually, the answer is clear, we need to devise a new pathways that avoid technological lock-in. The bottom line for resilient pathways is flexibility.

Clearly we also need to try to map out contours of such pathways. The challenges are manifold: drought and floods, provisioning of basic health, diversification of livelihood, and conservation of ecosystems. It is clear that one perfectly optimised solution will not work and we need to deploy many partial solutions. Sectors such as education and finance have traditionally not considered climate change problems in their ambit but need to do so. As we transit, the role of human agency becomes central since the way it is organised shapes both the definition of the problem and solution. NCVST (2009) has succinctly articulated the role different human agencies need to play as follows: various voices of justice-seeking civic movements and of innovative (especially local) markets–voices that seem to listen more carefully to the grass root concerns than many official bureaucracies–must be dovetailed into the programmes of national governments and international agencies. If adaptation to climate change is to be effective we need to devise a new compact among human agencies in developing and developed countries, among the civic movements, market and the government. Such compact must foster new knowledge that will assimilate and synthesise the natural and social sciences with local knowledge. We need approaches that bridge the micro, meso, and macro perspectives. Success depends on combinations of many elements that need be brought to fruition. Indeed, efforts at adaptation to climate change must be conceived, implemented through clumsy political compromises in a democratic space, outcome assessed and re-designed several times.

Our research broadly underscored these lessons.

Post Script

In all the case study sites, averting hunger, improving public health services to avoid infectious diseases, improving access to education, clean drinking water and sanitation, creating new forms of livelihood and minimising

social ills such as gender discrimination and exclusion constitute a "bundle of no-regret options" that must be implemented regardless of the extent of climate change impacts. Access to such measures fosters well-being to assist reduce vulnerability of the populations and help them adapt to impacts of climate change or adversity in general. A multifaceted and holistic approach can help achieve well-being which in-turn will help peoples' ability to adapt in an uncertain future brought about by global climate change.

The main challenge is not so much with the principles enunciated above *per se* but with the structural barriers that hinder suitable actions and progress. This limitation is particularly evident given the nature of the genesis of global climate change problem. Though residents of our case study sites emit no green house gases and contribute very little to the global climate change, they face vulnerability that must be dealt with. Some of the above challenges can be addressed at local and national levels, but these locations do not remain in isolation, rather are embedded within the wider sphere of global power and decision-making particularly in relation to the pathways towards mitigation of green house gases and in the allocation of resource necessary to support adaptation to climate change.

How much will be needed for adaptation? How will this resource be raised, governed and allocated? What mechanisms will ensure that the resources will actually effectively enable the vulnerable to adapt? How will the unintended consequences seen during the development-aid era that began at the end of Second World War avoided? These questions take us head on to the domain of the institution of foreign aid and international politics. And indeed the high voltage global politics seen in UNFCCC's fifteenth Conference of Parties (COP) in December 2009 in Copenhagen suggests that the barriers are likely to be even more entrenched.

Another challenge, though not new, yet of major significance, has surfaced. This challenge relates to climate science and assessment of the impacts of a warming global climate at regional and local scales. The postulation in IPCC's fourth report that Himalayan glaciers will vanish by 2035 has now been accepted by the venerated United Nations body as an error though it has become an issue of recriminatory global debate. Regardless of who is right or wrong in this debate, such assertion by the body did create unnecessary hype at the cost of realistic assessment of the snow processes in many parts of the world including the Himalaya and the nature of uncertainty that needed better appreciation for making effective public policies. In many developing countries climate science continues to remain in the periphery of public policy focus.

The progress of science has depended on the participation of contrarians in its evolution. Debates allow assumptions to be challenged and identify flaws. When the debates are open and straightforward, a rapid resolution and advances can sometimes be achieved.[5] In many debates, however, especially around climate change and natural resources management science acquires an ideological positioning due to differences in values. Indeed scientists themselves disagree. It does not take experience with too many controversies until

[5] See Sacks (1995)

[6] This is taken from the key note paper presented by J D. Prescoli to "The International Workshop on Water Awareness in Society Policy and Decision Making" Stockholm and published in *Water Nepal*. See Prescoli (1993).

one recognizes a variant of Newton Third Law, "To every PhD, you can find an opposite and equal PhD."[6] That such debates will happen is not an issue, but scientific evidence can be cherry picked and used in political posturing entailing serious risks as societies in vulnerable regions attempt to come to terms with the impact of climate change.

Our case study sites are data deficient regions. Given the limitations in data and climate science likely to prevail, certainty in prediction will remain an unachievable goal. Yet, we must make attempt to minimise uncertainty generated by absence of monitoring of rainfall and other hydrological sub-processes. The starting point may be to begin identifying both generic and specific constraints to adaptation, and collect limited sets of data on say precipitation and other sub process to overcome those. Installing rainfall stations in schools and in village-level organisations such as farmer-managed irrigation systems can be a creative approach of using civic science to establish a more robust local climate baseline at much lower cost but which are necessary for local adaptation plans to succeed. Such an approach would enable new knowledge, that brings together natural science and the social sciences as well as the scientific and local knowledge, to emerge. This new understanding will be central in our attempts to adapt to impacts of anthropogenic climate change.

ANNEXES

TABLE 1:
MEETINGS AND ACTIVITIES

Meeting	Date (Venue)	Comment
Preliminary coordination	2-5 February, 2006 (New Delhi)	This meeting set the preliminary criteria for the activities to be performed by each project partner. The basic outlines of the proposal and budget were discussed. Project action plans, monitoring and evaluation frameworks, accounting procedures, and timelines were developed and the areas of study in each country were identified. The schedule of the next meetings was also fixed.
First coordination and methodology	20-23 September, 2006 (Kathmandu)	This meeting revised the earlier timeline and presented guidelines for assessing vulnerability in each project site. Preliminary activities to be undertaken by each partner were discussed. A presentation on outcome mapping as a monitoring framework was delivered.
Second coordination and methodology	11-19 February, 2007 (Kathmandu)	Support for research methodologies, evaluation and monitoring frameworks and overall coordination were discussed. Coordination difficulties and issues as well as ways to resolve them were discussed.
Third coordination and methodology	25-27 April, 2007 (New Delhi)	Discussions focused on and finalised the plans for pilot implementation of adaptation and livelihood resilience activities in communities in the Nepal Tarai, Uttar Pradesh, and coastal Gujarat and Tamil Nadu. Each partner's adaptation plan was discussed and feedback was given. the monitoring and evaluation of these plans and outcome mapping were also discussed.
Follow-up meeting and writing workshop	April 29 to March 5, 2007 (Kathmandu)	The adaptation-specific interventions and underlying systems-for-adaptation matrix developed at the third coordination meeting was discussed and revised. A draft of the scoping paper based on the IDRC, DFID and NOAA activities of each partner was prepared.
Coordination meeting	November 2009	The content of the report was discussed and agreed.

Outputs and products

Publications and reports that draw on and included materials generated by this project include:

- *Working with the Winds of Change: Toward Strategies for Responding to the Risks Associated with Climate Change and other Hazards*, 2nd edition published in December 2007. The chapters that are of relevance to the IDRC project are:

  - Chapter 1: *Understanding the Winds of Change.*
  - Chapter 2: *Adapting to Climate Change and the Risks Associated with other Natural Hazards: Methods for moving from concepts to action.*
  - Chapter 3: *Climate Change and South Asian Impacts.*
  - Chapter 4: *Understanding Vulnerability, Building Capacity: Concepts, approaches and insights.*
  - Chapter 5: *Catalysing Adaptation to Disaster Risks and Climate Change: The shared learning dialogue process.*
  - Chapter 6: *Flood Disaster Impacts and Responses in Nepal Tarai's Marginalised Basins.*
  - Chapter 7: *Peripheral Heartland: Floods in Eastern Uttar Pradesh.*
  - Chapter 9: *Challenges and Prospects for Adaptation: Climate change and disaster risk reduction in Coastal Tamil Nadu.*
  - Chapter 10: *When Realities Shift: Responding to floods and the challenge of climate change in Ganga basin.*

- *Re-Imagining the Rural-Urban Continuum: Understanding the role ecosystem services play in the livelihoods of the poor in desakota regions undergoing rapid change* - a research gap assessment conducted for NERC, DFID and ESRC; published in June 2008. This study covers several parts of the world, but of relevance to the IDRC project covers South Asia and includes a field-based study along the Mustang (Nepal) - Gorakhpur (Eastern Uttar Pradesh, India) transect.

- *Catalyzing Climate and Disaster Resilience: Processes for Identifying Tangible and Economically Robust Strategies 2009.* This report includes a suit of methodology for cost benefit analysis of flood and drought risk reduction.

- *From Research to Capacity, Policy and Action Enabling Adaptation to Climate Change for Poor Populations in Asia through Research, Capacity Building and Innovation,* 2008. This report on adaptation research gaps was prepared under a separate project for IDRC and DFID.

- *Nepal Disaster Report* 2009 Government of Nepal and UNDP.

- *Local Responses to Too Much and To Little Water in the Greater Himalayan Region* 2009 Research Study being undertaken by ICIMOD.

- *Vulnerability Through the Eyes of the vulnerable Climate Change Induced Uncertainties and Nepal's Development Predicaments* 2009 DFID, Nepal climate vulnerability study team.

- *Exploring the Linkages between Adaptation and Development* 2009. Proceedings of International Scientific and Technical Conference, ISET-N and ISET Released at COP 15 Copenhagen.

- *Shifting the Response Terrain* 2009. The document brings together twenty two case studies crucial to policy making on adaptation options ISET-N and ISET. Released at COP 15 Copenhagen.

- *Climate Change Challenges in Nepal: Policy for Adaptation Decision-Making or Adaptive Policies* Study being done for ICIMOD.

- From Risk to Resilience Working Papers Series. The paper that are of relevance to the IDRC project are:

    - Paper 1: *The Cost-Benefit Analysis Methodology.*
    - Paper 2: *Pinning Down Vulnerability : From Narratives to Numbers.*
    - Paper 3: *Downscaling: Potential Climate Change Impacts in the Rohini Basin, Nepal and India.*
    - Paper 4: *Evaluating Costs and Benefits of Flood Reduction under Changing Climatic Conditions : Case of the Rohini River Basin, India.*
    - Paper 5: *Uttar Pradesh Drought Cost-Benefit Analysis, India.*
    - Paper 6: *Costs and Benefits of Flood Mitigation in the Lower Bagmati Basin: Case of Nepal Tarai and North Bihar.*
    - Paper 8: *Moving from Concepts to Practice : A Process and Methodology Summary for Identifying Effective Avenues for Risk Management Under Changing Climatic Condition.*
    - *Paper 9: Understanding the Costs and Benefits of Disaster Risk Reduction under Changing Climatic Conditions.*

- Development of a website: www.climate-transitions.org which includes numerous pages and papers developed on the basis of this and related projects. Literature research and uploading of relevant material to the Anukul project website.

- Some presentations and studies that drew on- and included materials generated in this study include:

    - IIASA-DPRI Disaster Forum, Stresa, Italy, September 2007.
    - Bali COP 13, December 2007 (in conjunction with the Red Cross and the ProVention Consortium).
    - DFID: Conflict and Humanitarian Areas Partners, London April 2008.
    - IDRC DAVOS Disaster Forum August 2008.
    - SAARC Workshop on Climate Change and Disaster: Emerging Trends and Future Strategies, Kathmandu 2008.
    - SDC Training Bangalore September 2008.
    - Stockholm Water Forum August 2008.

- DFID: Program officers in Asia and globally – coordination meeting in Nepal, April 2008.
- Rockefeller Foundation: Asian Cities Climate Change Resilience Network, January and May 2008.
- Nepal's National Adaptation Plan of Action (NAPA).
- Kathmandu to Copenhagen Regional Conference organized by Government of Nepal prior to COP 15 in Kathmandu.

- *International Scientific and Technical Conference On Adapting to Climate Change in Asia* August 29-30, 2009, Kathmandu.

- The above publications are being used as primary teaching materials in the Masters Level course in Interdisciplinary Water Management at Nepal Engineering College (NEC). The two modules being taught are Climate Change and Adaptation and Disaster Risk Reduction.

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