Chapter 5. Managing the Risks from Climate Extremes at the Local Level

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Executive Summary

Local refers to a range of places, social groupings, experience, management, institutions, conditions and sets of knowledge that exist at a scale below the national level. **Locales range from communities, villages, districts, suburbs, cities, metropolitan areas through to regions. Therefore they vary greatly in terms of disaster experience, nature of impact and responses, and stakeholders and decision-makers. [5.1]**

Disasters triggered by extreme events are most acutely experienced at the local level and numerous strategies to deal with extreme events have been developed at this scale with varying degrees of effectiveness. **Most adaptation to climate change effects on extreme events will take place at the local level. Some places have considerable experience with short-term climatic variability and this may provide the basis for longer-term adaptation to climate extremes. Developing strategies for improving disaster risk reduction in the context of climate change will need to be tailored to local conditions and experiences. [5.1]**

It is important to recognise that there is also great differentiation among locales at the same scale. In particular there are differences between those in developed and developing countries, and between those that are rural and urban. **These differences tend to exist across a continuum rather than being binary. Accordingly, developing strategies for disaster risk management in the context of climate change will require a considerable variety of approaches that reflect the respective local contexts. [5.1]**

There has been an increase in vulnerability at the local level in recent decades. Much of this increase can be attributed to social, political and economic change as well as localised environmental degradation. This trend is particularly evident in developing countries. **This presents a major challenge for adaptation to climate change. Addressing climate change and changing extreme events will require addressing much wider issues relating to sustainable development. [5.1]**

Measures adopted at the local level range from those that help individuals cope during or immediately before extreme events such as evacuation and taking shelter in place (often supported by the provision of early warnings), through structural measures that seek to 'protect' people and communities from extremes (e.g. levees, dykes or stop banks, river dredging and straightening, emergency sandbagging and sea walls, measures that seek to counter environmental degradation (such as watershed management) and approaches that seek to avoid (through land use planning and relocation, for example) or offset disaster losses such as surplus food production and its storage. **In many places there is a tendency to rely on structural measures, which encourage settlement and the intensification of livelihoods in places that are believed to be protected. In the event of supra-design events even greater disasters unfold and there is a greater dependence upon relief and reconstruction, and reliance on external sources of assistance [5.2, 5.3].**

Disaster relief and reconstruction may be seen as activities that are required to make up for failures of disaster risk reduction measures to be effective. **Relief plays an important humanitarian role but it does have associated problems including inappropriate forms of assistance, removal of local autonomy in post-disaster decision making and the undermining of local disaster reduction measures. [5.2]**

Following disasters the recovery and reconstruction phases offer opportunities to 'build back better'. However experience indicates that this is difficult for many localities were there are limited spatial options for relocation or limited financial resources for improving structural and livelihood resilience. **Successful adaptation to climate change will need to address these issues. [5.3]**

There is a strong and complex link between local livelihood security and extreme events. **While communities with secure sustainable livelihoods are likely to be better placed to cope with climate change and changing patterns of climatic variability, extreme events may also undermine local sustainability and increase vulnerability. Building sustainable livelihoods is an important adaptation to climate change. [5.3]**

Managing risk in the context of climate change offers a range of opportunities and challenges at the local level. **The mix of opportunities and challenges is likely to be unique for each locality or community. For this reason generic approaches are likely to be unsuccessful. [5.3]**

Components of localised disaster risk management in the context of climate change include: anticipating risks as affected by climate change; communicating likely changes in disaster risk to enable local action; empowering local communities to enable them to use their local knowledge and information supplied to them to develop locally appropriate strategies; encouraging, strengthening and or building on existing local social networks (and drawing on local socil capital) as a basis for sustainable risk management; integrating and valuing local knowledge which for many localities is much more place specific than other forms of knowledge including that derived from climate models; and facilitating local government and non-government initiatives and practices. **Many of these components of localised disaster risk management in the context of climate change are consistent with the building of local capacities and sustainable livelihoods. [5.3]**

There are significant challenges to disaster risk management with certain groups experiencing greater levels of vulnerability. **These inequalities reflect gender, age, wealth (class), ethnicity, health and disabilities. For many individuals and communities these may coalesce further intensifying vulnerability. They may also be reflected in differences in access to livelihoods and entitlements, or declining access also lead to reductions in vulnerability. [5.4]**

The rapid urbanisation of the global population and the growth of megacities, especially in developing countries, have led to the emergency of highly vulnerable urban communities, especially those in informal settlements. **Addressing these critical vulnerabilities will require addressing their social, political and economic driving forces. These include rural to urban migration, changing livelihoods and wealth inequalities. [5.4]**

The costs of disasters at the local level are difficult to estimate. Similarly, the identification of climate change effects at the local level is complicated. Accordingly, estimating the costs of adapting to changes in climate extremes is also difficult to estimate. **There is a need for further development of tools to enable such costs to be assessed. [5.4]**

Adapting to climate extremes may not be possible in all local settings. **There are many locations that are currently exposed to frequent disruption from extremes and from which displaced people temporarily or permanently migrate. If climate extremes occur more frequently or with greater magnitude (or duration in the case of droughts) in situ adaptation may become ineffective or impossible without severe hardship and suffering. In such cases local places may be rendered uninhabitable with the resulting migration of individuals or relocation of whole communities. For at least some of these migrants there will be serious dislocation and disadvantage as a result of their forced migration. [5.2, 5.4]**

Managing disaster risk at the local level can be achieved using a variety of approaches. There are three key elements including: assessment of local exposure taking into account community location and the suite of likely extreme events and their characteristics such as frequency and magnitude; vulnerability analyses which identify community sensitivities; and post disaster assessment. **Many of these activities can be conducted at the community level, using community resources and local knowledge. It may also be beneficial for local knowledge to be combined (though not subsumed by) with other information such as may be generated by climate researchers, disaster reduction agencies and development practitioners (including both governmental and non-governmental organisations). [5.5]**

There is also considerable potential for transfers within communities, among communities and between communities and other levels (national and international). **These include social transfers such as through kinship networks, social protection programmes that seek to assist poorer community members and reduce vulnerability, insurance and micro insurance which spreads losses from extreme events both temporarily and spatially. [5.2, 5.5]**

Disaster risk management in the context of climate change is a process. **Adaptation to changing climate extremes, together with changing mean conditions, is not a set of finite actions but an ongoing process incorporating long-term learning, changing scenarios, and incorporating changes that are not climate related. There is a need for institutional change from top-down approaches to ones that increase local capacities and build resilience. Accordingly adaptation strategies need to be comprehensive, set in the context of sustainable development and flexible. Financial support for adaptation may be required for long periods of time. [5.5]**

There remains a need for a comprehensive database or inventory of disaster occurrence, disaster effects and disaster response. **While there is a vast amount of information about specific events at different scales very little is coordinated at levels below the national.** Geospatial and other technologies exist for the management of sub-national disaster data and these should be carefully utilised. **[5.6]**

5.1. Introduction

As we enter into the second decade of the 21st Century, human and economic losses from weather-related catastrophes continues to increase. In terms of overall losses, 2005, 1995, and 2008 rank among the most expensive years for natural hazard monetary losses worldwide (Geo Risks Research, 2009). Climate variability and change is probably contributing to these weather-related extremes (see Chapter 3) and in combination with human settlement patterns, increasing the exposure to loss throughout the world. However, such losses will not be uniformly distributed across the globe, nor will their impacts. Some communities will be able to cope with disaster risks, while others have limited disaster resilience and capacity to cope with and adapt to climate variability and extremes. This is the topic of this chapter: to present evidence on where disasters are experienced, how disaster risks are managed at present, and the variability in coping mechanisms and capacity in the face of climate variability and change, all from the perspective of local places and local actors.

The impacts of disasters are most acutely felt at the local level. However, the word local has many connotations, and the definition of local influences the context for disaster risk management, the experience of disasters, and conditions, actions and adaptation to climate changes. For the purposes of this report, we define local as the set of experiences and management that arise from grass roots actions; indigenous knowledge, skills, and resources about the place; and formal and informal governance structures. Local includes the set of institutions that maintain and protect social relations that are below state and province levels such as local government, local judiciary, or local licensing authorities which normally have some administrative control over space or resources. Local includes the set of conditions and knowledge that are geographically and historically bounded and where choices and actions for disaster risk management and adaptation to climate extremes are initially independent of national interventions. Local includes functional or physical units such as watersheds, ecological zones, or economic regions, and the institutions that govern their use and management. Within the local level, there are many different locales (the explicit spatial boundaries of different settings or collectives where social interactions occur). These locales can range from a community, village, district, suburb, city, metropolitan area, region—all with distinct spatial and jurisdictional boundaries, and different needs, identities, and voices. The differences in scale not only influence who and what is at risk, but more importantly the potential geographical extent of the likely impact, and the likely stakeholders and decision-makers.

One particular type of locale of interest to this chapter is community. A community is a group of people (larger than households) who interact with one another and who live in a common location (community of location) (Johnston, 2000). But a community is also defined as a group of people organized around a set of common values or ideals such as religious values, ethnic identities, professional practice, etc. We use the term community to refer to both: a spatially-defined entity with social interaction among residents; and the collection of relationships or social bonds that are a-spatial (communities of propinquity or communities of culture), but which influence opportunities and actions at the local level. Community-based management includes both the community of location and the communities of culture.

Local places have considerable experience with short-term coping responses and adjustments to disaster risk (UNISDR, 2004). Climate sensitive hazards such as flooding, tropical cyclones, drought, heat, and wildfires regularly affect many localities with frequent, yet low level losses (UNISDR, 2009). Because of their frequent occurrence, many localities have developed extensive disaster risk management practices, suggesting a form of climate-sensitive coping that is already in place. On the other hand, response and long term adaptation to climate extremes will require disaster risk management that acknowledges the role of climate variability in fostering sustainable and disaster resilient places in the face of climate change and uncertainties. This can mean a modification and expansion of local disaster risk management principles and experience through innovative organizational, institutional, and governmental measures at all jurisdictional levels (local, national, international). However, such arrangements may constrain or impede local actions and ultimately limit the coping capacity and adaptation of local places.

In preparing this chapter we have been struck by the considerable range of climate-sensitive risk experience at the local level and the great variety of strategies that have been developed to reduce risk. Climate risks are mediated by culture, class, society, economy, politics and local environmental conditions. The structure of this chapter is thematic rather than regional or based on development status. However, it is important to keep these factors in mind.

While the differences in the effects of natural disasters among countries is usually demonstrated using data at the national level (e.g, EM-Dat; IFRC), the differential effects are experienced at the local level and many measures to reduce disaster risk will also be applied at this scale. One of the most striking differences in vulnerability is that which distinguishes communities in developing countries from those in the industrialized nations. In this chapter we have addressed the issue of local disaster risk and disaster risk reduction using a variety of sources of information (see Box 5-1). However, given the wide differences between developing and developing countries it is clear that single solutions for risk reduction are unlikely to be possible. Moreover, it is possible that the processes of development as currently practiced, in addition to a history of colonial exploitation, may be increasing, rather than reducing disaster vulnerability at the local level. Those choosing strategies for reducing disaster risk and adapting to climate change in developing countries need to take these processes into account. Similarly, there are differences between urban and rural communities in terms of disaster and climate change vulnerability and disaster risk and adaptation options. For example, in many rural areas livelihoods have a strong subsistence component (i.e. the producer is the consumer) and climate impacts may have considerably more direct effects than upon some urban dwellers whose livelihoods may be less dependent upon climatic conditions. Conversely, the effects of heat waves are often more severe in urban than rural areas.

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Box 5-1. Capturing Local Knowledge: The Use of Grey Literature

What is grey literature? Grey literature non-journal based sources of information, data, and analyses that have not gone through the traditional scientific peer review process that is the norm for refereed journal publications. According to the Sixth International Conferences on Grey Literature, it is "information produced on all levels of government, academics, business and industry in electronic or print formats not controlled by commercial publishing, i.e. where publishing is not the primary activity of the producing body" (www.greynet.org, accessed

May 18 2010). Grey literature is formal, unpublished scientific and technical communication ((Sondergaard *et al.*, 2003)) and includes reports (policy statements, technical reports, government documents, project reports, annual reports), working papers, conference proceedings and papers, theses and dissertations, brochures and pamphlets, audiovisual materials, and internet-based materials. The use of grey literature varies widely by scientific field. In economics, for example working paper series are quite common, but their impact (based on citations) is similar to low impact journals ((Frandsen, 2009)). Much disaster risk management literature, especially in, or relating to developing countries falls into this categories. Such literature includes key themes in disaster risk management such as those produced by the International Strategy for Disaster Reduction (ISDR), national level reports by governmental agencies, country reports, and project reports at various local levels. While the grey literature is not always peer reviewed in an academic sense, much of it is subjected to some form of review ranging from widespread consultation with peers outside the agency or entity to in house checking. In some instances, such as with IPCC reports and World Bank reports, it is often more rigorously peer reviewed than some journals.

In recent years grey literature has made critical contributions to a number of projects on environmental change ((Chavez *et al.*, 2007; Costello, 2007)(Thatje *et al.*, 2007);) including intergovernmental scientific research ((MacDonald *et al.*, 2007)) This includes the IPCC, where the Fourth Assessment clearly states, "Its emphasis is on new knowledge acquired since the IPCC Third Assessment (2001). This requires a survey of all published literature, including non-English language and 'grey' literature such as government and NGO reports ((Parry *et al.*, 2007))." However, use of grey literature is challenged by some scientists and other observers who are concerned by its lack of rigor. The advent of the internet has changed the accessibility and availability of grey literature, giving it much wider circulation and in many cases increased status.

Why Use Grey Literature? There are a number of reasons why grey literature is used. First, there is a dearth of peer-reviewed research covering community/local level disaster risk management and climate change adaptation. This is especially true for developing countries. While a small amount of refereed literature is emerging, it may not be published in sufficient quantity or in a timely fashion to be included in this report. Second, much of the community based work is not conducted by researchers motivated to publish in peer-reviewed journals. Instead, the motivation for the research is action-oriented (focus on doing, not observing). In many instances the career paths of the researchers are not dependent on peer-reviewed research, but rather actionable results. Third, in many developing countries there is less of a tradition of publishing in scientific journals, oftentimes due to the qualitative nature of the work. Instead, most of the literature on disaster risk appears in reports from governments and organizations. Finally, there is a concern on the part of many field investigators that research interferes with the ethos of participatory and action research approaches. Failure to include the grey literature will bias our findings toward developed country disaster risk management and adaptation.

Who Writes Grey Literature? Grey literature is created by a very wide range of actors including research scientists, especially but not exclusively those working in non-academic institutions, and researchers working as private consultants. A great deal of grey literature is generated by governments including international (e.g. ISDR, UNDP, World Bank) and regional (Secretariat of the Pacific Regional Environment Program) intergovernmental organizations and national and local government agencies. In addition to these sources grey literature may also be prepared by non-governmental organizations and civil society (at the international, regional, national and local levels). The authors of GL also range is qualification from those with PhDs and/or those with considerable practical or policy experience through to some with little or no tertiary education at all. A significant proportion of the grey literature accessed for this chapter has been written by individuals with PhDs and strong (refereed) publication records and there is a steady contribution from researchers retired from their institutional bases that work on contract.

How Do We Assess Quality? A major concern with grey literature is the assessment of quality given that it often has not been subject to an academic process of peer review as is the case with journal articles. How can we assess the quality as good?

The following are a set of approaches that were utilized in this report. First, we can apply our own internal peer review. Most of the working group members have experience at peer review and have been involved in assessment of journal articles and other research products and can apply the same standards. This could be assisted by the provision of guidelines (see Table 5-1). Second, we could send reports to other members of report team who have relevant expertise for a secondary evaluation. For example, the requesting chapter team would need to be explicit about the qualities of the report and why it has been included to the secondary reviewer, who would then conduct an independent evaluation of that section of the document to be used. In order to ensure transparency of the process, the secondary review would ideally be conducted by someone outside the immediate chapter writing team such as the review editor. Third, a process of triangulation could be employed using separate reports that reinforce the same issue although it is important to ensure that they are not related (emanating from the same organisation or author). Fourth, grey literature should only be used where peer reviewed material is not available. Figure 5-1 indicates a possible flow path for accepting grey literature for this chapter and the special report.

[INSERT TABLE 5-1 HERE:
Table 5-1: Guidelines for grey literature inclusion.]

[INSERT FIGURE 5-1 HERE:
Figure 5-1: Procedure for assessing grey literature.]

Practitioner experience and local knowledge are key components in understanding disaster risk management and climate change adaptation at the local level. Failure to include the grey literature in this assessment will result in a great majority of vulnerable communities being excluded from the IPCC process as their voices and experiences will not be heard, nor represented in the assessment.

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Finally, it is also very important not to treat these considerations in a binary manner (see Figure 5-2). The wealth, level of industrialization or development status of communities ranges in a continua from those in least countries to those in the wealthiest of nations. Similarly, the rural-urban divide is blurred, and the size of urban areas ranges from mega cities to small towns. Along these continua lie a great variety of vulnerabilities, experiences and possibilities for adaptation (represented by the grey area).

[INSERT FIGURE 5-2 HERE:
Figure 5-2: The continuum of development and urbanization.]

There are a number of key themes and messages in the chapter. First, some local places have considerable experience with short-term climate-sensitive hazards on a fairly routine basis. This knowledge can provide the basis for longer-term adaptation to climate variability and extremes. Second, improvements in any type of disaster risk management may have local benefits independent of climate change and such improvements will help foster disaster resilience in the short- and long-term. Finally, long-term adaptation to climate will require that disaster risk management explicitly consider climate variability and change. Strong and flexible climate and disaster risk management agencies may not require new institutional structures, although there will be exceptions. Shared responsibilities for coping and adaptation are needed to harness local knowledge, experience, and action and integrate this into the more top-down strategies emanating from national and international disaster risk management and adaptation to climate change strategies. A one-size strategy will certainly not fit all at the local level.

5.2. Community Coping

Communities everywhere have developed ways of interacting with their environment. Often these interactions are beneficial and provide the livelihoods that community members depend on. At the same time communities have developed ways of responding to disruptive environmental events. These coping mechanisms include measures which seek to modify the impacts of disruptive events, modify some of the attributes or environmental aspects of the events themselves, and/or actions to share or reduce the disaster risk burdens (Burton *et al.*, 1993). It is important to acknowledge that while climate change may alter the magnitude and/or frequency of some climatic extremes, other social, political, or economic processes (many of them also global in scale) are reducing the abilities of communities to cope with disaster risks and climate-sensitive hazards. Accordingly, disaster losses have increased significantly in recent decades ((UNDP, 2004; UNISDR, 2004)). These social, economic, and political processes are complex and deep seated and present major obstacles to reducing disaster risk, and are likely to constrain efforts to reduce community vulnerabilities to extreme events under conditions of climate change.

There are a variety of existing measures that local communities utilize in coping with disaster risk. These include pre-event activities such as disaster risk education and early warning systems; individual and collective protective actions such as evacuation; prevention strategies such as structural measures (seawalls and levees); non-structural measures such as land use and ecosystem protection; population displacements (both temporary and permanent), and disaster relief.

5.2.1. Generation, Receipt, and Response to Risk Information

The disaster research and emergency management communities have shown that warnings of impending hazards need to be complemented by information on the risks actually posed by the hazards and likely strategies and pathways to mitigate the damage in the particular context in which they arise. Effective "early warning" implies information interventions into an environment in which much about vulnerability is assumed ((Olson, 2000)(Olson, 2000)). This backdrop is reinforced through significant lessons that have been identified from the use of seasonal climate forecasts over the past 15 years ((Podestá *et al*., 2002; Pulwarty, 2007)) It is now widely accepted that the existence of predictable climate variability and impacts are necessary but not sufficient to achieve effective use of climate information, including seasonal forecasts. The practical obstacles to using information about future conditions are diverse, ranging from limitations in modeling the climate system's complexities (e.g. projections having coarse spatial and temporal resolution, limited predictability of some relevant variables, and forecast skill characterization), to procedural, institutional, and cognitive barriers in receiving or understanding climatic information, and the capacity and willingness of decision-makers to modify actions ((Kasperson *et al*., 1988; Marx *et al*., 2007; Patt and Gawa, 2002; Roncoli *et al*., 2001; Stern and Easterling, 1999)). In addition functional, structural, and social factors inhibit joint problem identification and collaborative knowledge production between providers and users. These include divergent objectives, needs, scope, and priorities; different institutional settings and standards, as well as differing cultural values, understanding, and mistrust ((Pulwarty *et al*., 2004; Rayner *et al*., 2005; Weichselgartner and Kasperson, 2010)).

The generation and receipt of risk information occurs through a diverse array of channels. Policies and actions affecting communications and advanced warning have a major impact on the adaptive capacity and resilience of livelihoods with for example, access to reliable and low cost telecommunications services are central factors influencing the ability of local populations to diversify their income strategies. The collection and transmittal of weather (and climate)-related information is, often a governmental function while communications systems such as cell phone networks tend to be private.

Examples of risk information generation and diffusion efforts within disasters research and response communities including- interpersonal contact with particular researchers, planning and conceptual foresight (Red Cross/Red Crescent brochures), outside consultation on the planning process (FEMA), user-oriented transformation of information and individual and organizational leadership ((NRC (National Research Council), 2006)) (see Box 5-2 for additional sources of risk information).

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Box 5-2. Selected Sources of Risk Information

There are many sources of risk, vulnerability, and warning information. Among them are the Asia Disaster Preparedness Centre, Natural Hazards Research and Applications Information Center, at the University of Colorado, South Carolina Hazards and Vulnerability Research Institute, Caribbean Disaster Emergency Management Agency, Latin America Vulnerability Project, National Early Warning Units, in Southern Africa, National Weather Service (NWS) Warning Program and the NOAA/Columbia University International Research Institute for Climate and Society. More generally the space in which problem definition, information needs assessments, and knowledge co-production is usually takes the form of:

- Workshops and meetings (shared scenario construction including agro-climatic decision calendars
- Presentations and briefings (incl. locally organized events, e.g. hearings)
- One-on-one technical assistance and training
- Coordination with other ongoing projects
- Web site development and maintenance
- Courses on climate impacts and adaptation (see below)
- Media (local and mass media and information telenovelas etc.)

((Perarnaud *et al.*, 2004; Pulwarty, 2007; Van Aalst *et al.*, 2008))

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Significant advancements in warning systems in terms of improved monitoring, instrumentation, and data collection have occurred, but the management of the information and its dissemination to at risk populations is still problematic ((Sorensen, 2000)). Researchers have identified several aspects of information communication, such as, communication channels, stakeholder awareness, key relationships, and language and terminology, which are socially contingent in addition to the nature of the predictions themselves. More is known about the effects of these message characteristics on warning recipients, than is known about the degree to which generators and providers of information including hazards researchers address them in their risk communication messages. For example, warnings may be activated (such as the tsunami early warning system), yet fail to reach potentially affected communities ((Oloruntoba, 2005)). Similarly, many communities do not have access to climate-sensitive hazard warning systems such as tone alert radio, emergency alert system, reverse 911, and thus never hear the warning message, let alone act upon the information ((Sorensen, 2000)). On the other hand, Valdes ((Valdes, 1997)) demonstrated that flood warning systems based on community operation and participation in Costa Rica make a difference as to whether early warnings are acted upon to save lives and property.

5.2.2. Individual/Collective Action

At the individual and household level, individuals engage in protective actions to minimize the impact of extreme events on themselves and their families. The range and choice of actions are often event specific and time dependent, but they are also constrained by location, adequate infrastructure, socioeconomic characteristics, and access to disaster risk information (Tierney *et al.*, 2001). For example, evacuation is used when there is sufficient warning to temporarily relocate out of harm's way such as for tropical storms, flooding, and wildfires. Collective evacuations are not always possible given the location, population size, transportation networks, and the rapid onset of the event. At the same time, individual evacuation may be constrained by a host of factors ranging from access to transportation, monetary resources, health impairment, job responsibilities, and the reluctance to leave home. There is a consistent body of literature on hurricane evacuations in the U.S., for example which finds that 1) individuals tend to evacuate as family units, but they often use more than one private vehicle to do so; 2) social influences (neighbors, family, friends) are key to individual and households evacuation decision-making; if neighbors are leaving then the individual is more likely to evacuate and vice versa; 3) risk perception, especially the personalization of risk by individuals is a more significant factor in prompting evacuation than prior adverse experience with hurricanes; and 4) social and demographic factors (age, presence of children, elderly, or pets in households, gender, income, disability, and race or ethnicity) either constrain or motivate evacuation depending on the particular context ((Adeloa, 2009; Bateman and Edwards, 2002; Dash and Gladwin, 2007; Dow, K. and Cutter, S. L., 2002; Dow and Cutter, 1998; Dow and Cutter, 2000; Edmonds and Cutter, 2008; Lindell *et al.*, 2005; McGuire *et al.*, 2007; Perry and Lindell, 1991; Sorensen *et al.*, 2004; Sorensen and Sorensen, 2007; Van Willigen *et al.*, 2002; Whitehead *et al.*, 2000)).

A different protective action, shelter-in-place occurs when there is little time to act in response to an extreme event or when leaving the community would place individuals more at risk (Sorensen *et al.*, 2004). Seeking higher ground or moving to higher floors in residential structures to get out of rising waters is one example. Another is the movement into interior spaces within buildings to seek refuge from strong winds. In the case of wildfires, shelter in place becomes a back-up strategy when evacuation routes are restricted because of the fire and then include protecting the structure or finding a safe area such as a water body (lake or backyard swimming pool) as temporary shelter ((Cova *et al.*, 2009)). In Australia, the shelter in place action is slightly different. Here there is local community engagement with wildfire risks with stay and defend or leave early (SDLE) policy. In this context, the decisions to remain are based on social networks, prior experience with wildfires, and involvement with the local fire brigade ((McGee and Russell, 2003)). The study also found that rural residents were more self-reliant and prepared than suburban residents ((McGee and Russell, 2003)).

The social organization of societies dictates the flexibility in the choice of protective actions—some are engaged in voluntarily (such as in the U.S., Australia, and Europe), while other protective actions for individuals or households are imposed by state authorities such as Cuba and China. Planning for natural disasters is a way of life for Cuba, where everyone is taught at an early age to mobilize quickly in the case of a natural disaster ((Bermejo, 2006; Sims and Vogelmann, 2002). The organization of civil defense committees at block, neighborhood, and community levels working in conjunction with centralized governmental authority makes the Cuban experience unique ((Bermejo, 2006)(Sims and Vogelmann, 2002)).

In many traditional or pre-capitalist societies it appears that mechanisms existed, which protected community members from periodic shocks such as natural hazards. These mechanisms which are sometimes referred to as the *moral economy*, were underpinned by reciprocity, often linked to kinship networks, and served to redistribute resources to reduce the impacts on those who had sustained severe losses and were identified by Scott ((Scott, 1976)) in Southeast Asia, Watts ((Watts, 1983)) in Western Africa and Paulson ((Paulson, 1993)) in the Pacific Islands. The moral economy incorporated social, cultural, political and religious arrangements which ensured that all community members had a minimal level of subsistence (see Box 5-3).

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Box 5-3. Collective Behavior and the Moral Economy at Work

One example of such a system is the *Suqe*, or graded society, which existed in northern Vanuatu. In the *Suqe* 'big men' achieved the highest status by accumulating surpluses of valued goods such as shell money, specially woven mats and pigs. Men increased their grade within the system by making payments of these goods to men of higher rank. In accumulating the items men would also accumulate obligations to those they had borrowed from. Accordingly networks and alliances emerged among the islands of northern Vanuatu. When tropical cyclones destroyed crops, the obligations could be called in and assistance given from members of the networks who lived in islands that escaped damage ((Campbell, 1990)). A variety of socio-political networks, that were used to offset disaster losses, existed throughout the Pacific region prior to colonization ((Campbell, 2006) (Paulson, 1993; Paulson, 1993; Sahlins, 1962)). A number of processes associated with colonialism, the introduction of the cash economy and conversion to Christianity, as well as the provision of post-disaster relief has caused a number of elements of the moral economy to fall into disuse ((Campbell, 2006)).

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There is some controversy over the significance of the notion of moral economy with some writers claiming that it oversimplified intra- and inter-community linkages in pre-capitalist settings. In doing so it does not recognize the inequalities in some of the social systems that enabled such practices to be sustained and tended to perhaps provide an unrealistic notion of a less risky past. In addition kinship based sharing networks may foster freeloading among some members ((diFalco and Bulte, 2009)). Nevertheless, a reduction in traditional coping mechanisms including the moral economy is reflected in growing disaster losses and increasing dependency on relief ((Campbell, 2006)).

Collective action to prepare for or respond to disaster risk and extreme climate impacts can also be driven by localized organizations and social movements. Many such groups represent networks or first-responders for climate-sensitive disasters. However, there are many constraints that these movements face in building effective coalitions including the need to connect with other movement organizations and frame the problem in an accessible way ((McCormick, 2010)).

5.2.3. Structures and Structural Mitigation

Structural interventions to reduce the effects of extreme events generally refer to engineering work like dykes, embankments, seawalls, river channel modification, flood gates, and reservoirs, etc. Although these structural interventions can achieve success in reducing disaster impacts, they can also fail due to lack of maintenance or due to extreme events. Most structural measures are short-term solutions. Furthermore, technical considerations should not preclude socio-economic considerations ((WMO, 2003)). Implementing structural measures that involve participatory approaches from communities who are proactively involved often leads to more sustainable outcomes. One of the key reasons why local projects are often ineffective is that they are approved on the basis of technical information alone, rather than based on both technical information and local wisdom ((ActionAid, 2005)). In addition, national legislation can have important influences on the choice of disaster risk reduction strategies at the local level as can local and national institutional arrangements that often favor technocratic responses over other non-structural approaches ((Burby, 2006)).

The method of protecting an entire area by building a dyke has been in use for thousands of years and is still being applied by communities in flood-prone countries. Embankments, dykes, levees and floodwalls are all designed to protect areas from flooding by confining the water to a river channel, thus protecting the areas immediately behind them. Building dykes is one of the most economical means of flood control ((Asian Disaster Preparedness Centre, 2005)). Dykes built by communities normally involve low technology and traditional knowledge (such as earth embankments as shown in Figure 5-3). Sand bagging is also very popular for flood-proofing in Asia. Generally, structures that are built of earth are highly susceptible to erosion leading to channel siltation and reduced water conveyance on the wet side and slope instability and failure on the dry side. It can also reduce the height of the structure making it less effective. Slopes can be stabilized by various methods, including turfing by planting vegetation such as Catkin grass and Vetiver grass in Bangladesh and Thailand, respectively.

[INSERT FIGURE 5-3 HERE:
Figure 5-3: Earth embankment along the river (left) with stabilization (right) (ADPC, 2005).]

Large scale structural measures are often implemented using cost-benefit analyses and technical approaches. In many cases, particularly in developed countries, structural measures are subsidized by national governments and local governments and communities are required to cover only partial costs. In New Zealand this led to a preponderance of structural measures despite planning legislation that enabled non-structural measures. As a result the catastrophic potential was increased and development intensified in ‘protected’ areas only to be seriously devastated by supra-design events ((Ericksen, 1986)). This so-called “levee effect”, actually increases disaster risk rather than decreasing it ((Montz and Tobin, 2008; Tobin, 1995)). Reduction of centralized subsidies in the mid-1980s and changes in legislation saw greater responsibility for the costs of disaster risk management falling on the communities affected and a move towards more integrated disaster risk reduction processes within New Zealand ((Ericksen *et al*., 2000)).

Building codes closely align with engineering and architectural structural approaches to disaster risk reduction ((Kang *et al*., 2009)(Petal *et al*., 2008)). This is accompanied by the elevation of buildings and ground floor standards in the case of flooding ((Kang *et al*., 2009)). One dilemma with building codes is their implementation at the local level. Instances of earthquake and inundation-generated building damages occur because of noncompliance ((Burby *et al*., 1998)).

5.2.4. Land Use and Ecosystem Protection

Changes in land use not only contribute to global climate change but they are equally reflective of adaptation to the varying signals of economic, policy, and environmental change ((Brown, D., A. Agrawal , S. Cheong , R. Chowdhury, C.Polsky, ; Lambin, E. F., B. L. Turner, H. J. Geist, S. B. Agbola, A. Angelsen, J. W. Bruce, O. T. Coomes, R. Dirzo, G. Fischer, C. Folke, P. S. George, K. Homewood, J. Imbernon, R. Leemans, X. Li, E. F. Moran, M. Mortimore, P. S. Ramakrishnan, J. F. Richards, H. Skånes, W. Steffen, G. D. Stone, U. Svedin, T. A. Veldkamp,

C. Vogel,J.Xu, 2001)). Disaster management through local land use planning embedded in zoning, local comprehensive plans, and retreat and relocation policies is a popular approach to disaster risk management, although some countries and rural areas may not have formal land use regulations that restrict development or settlement. As land use management regulates the movement of people and industries in hazard-prone zones, it faces development pressures and real estate interests accompanied by property rights and the takings issue ((Burby, 2000; Thomson, 2007; Titus, J., D. Hudgens, D. Trescott, M. Craghan, W. Nuckols, C. Hershner, J. Kassakian, C. Linn, P. Merritt, T. McCue, J. O'Connell, J. Tanski,J.Wang, 2009)). Buffer zones, setback lines in coastal zones, and inundation zones based on flood and sea-level rise projections can result in controversies and lack of enforcement that bring about temporary resettlement, land speculation, and creation of new risks ((Jha *et al*., 2010)(Ingram *et al*., 2006)).

Formal approaches to land use planning as a means of disaster risk management are often less appropriate for many rural areas in developing countries where traditional practices and land tenure systems operate. Similar restrictions are found in regard to slums and squatter settlements. Poverty and the lack of infrastructure and services increase the vulnerability of urban poor to adverse impacts from disasters and national governments and international agencies have had little success in reversing such trends. Most successful efforts to bring about reductions in exposure have been those that have been locally led and that build on successful local initiatives ((Satterthwaite *et al*., 2007)).

Land acquisition is another means for protecting property and people by relocating them away from hazardous areas ((Olshansky and Kartez, 1998)). Many jurisdictions have the power of eminent domain to purchase property but this is rarely used as a form of disaster risk reduction ((Godschalk *et al*., 2000)). Voluntary acquisition of land, for example, requires local authorities to purchase exposed properties, which in turn enables households to obtain less risky real estate elsewhere without suffering large economic losses in the process ((Handmer, 1987)). Given the large number and high value of exposed properties in coastal zones in developed countries such as the United States and Australia this buy out strategy is cost-prohibitive and thus, rarely used ((Anning and Dominey-Howes, 2009)). Similarly, voluntary acquisition schemes for developing countries are equally fraught with problems as people have strong ties to the land, and land is held communally in places like the Pacific Islands where community identity cannot be separated from the land to which its members belong ((Campbell, 2010b)). Land use planning alone, therefore, may not be successful as a singular strategy but when coupled with related policies such as tax incentives or disincentives, insurance, and drainage and sewage systems it could be effective ((Cheong, 2011; Yohe and Newmann, 1997)).

Ecosystem conservation offers long-term protection from climate extremes. The mitigation of soil erosion, landslides, waves, and storm surges are some of the ecosystem services to protect people and infrastructure from extreme events and disasters ((Sudmeier-Rieux, K., H. Masundire, A. Rizvi,S.Rietbergen (eds.), 2006)). The 2005 Asian tsunami, for example, attests to the utility of mangroves, coral reefs, and sand dunes in alleviating the influx of large waves to the shore ((Das and Vincent, 2009)). The use of dune management districts to protect property along developed shorelines has achieved success in many places along the U.S. eastern shore and elsewhere ((Nordstrom, 2000; Nordstrom, 2008)). While the extent of their protective ecosystem functions is still debated ((Gedan, K. B., M. L. Kirwan, E. Wolanski, E. B. Barbier,B.R.Silliman, 2011)), the merits of the ecosystem services in general are proven, and development of quantified models of the services is well under way ((Nelson, E., G. Mendoza, J. Regetz, S. Polasky, H. Tallis, D. R. Cameron, K. M.A. Chan, G. C. Daily, J. Goldstein, P. M. Kareiva, E. Lonsdorf , R. Naidoo, T. H. Ricketts,M.R.Shaw, 2009)). These nonstructural measures are considered to be less intrusive and more sustainable, and the necessity for integrating engineering responses and vegetation barriers as responses to climate extremes have begun to be recognized ((Cheong, 2011; Francis, R.A. , S. Falconi, R. Nateghi, S.D. Guikema, in Ed,S.Cheong, 2011)).

5.2.5. Surplus and Storage of Resources

Communities may take a range of approaches to cope with disaster induced shortages. These include production of surpluses and their storage. And if these fail, rationing of food may occur. In pre-colonial times many communities produced food surpluses which enabled them to manage during periods of seasonal or disaster initiated disruptions to their food supplies. In Pacific Island communities food crops such as taro and breadfruit were often ensiled in leaf-lined pits, yams could be stored for several years in dry locations, and most communities maintained famine foods such as wild yams (dioscorea spp.), swamp taro (cyrtosperma spp.) and sago (metroxylon spp.) which were only harvested during times of food shortage ((Campbell, 2006)). The provision of disaster relief among other factors has seen these practices decline ((Campbell, 2010)). Stockpiling and prepositioning of emergency response equipment, materials, foods and pharmaceuticals and medical equipment is also an important form of disaster preparedness at the local level, especially for indigenous communities.

Rationing at the local level is often instituted at the level of households, particularly poor ones without the ability to accumulate wealth or surpluses, in the face of disaster induced declines in livelihoods. Most rationing takes place in response to food shortages and is for most poor communities, the first response to the disruption of livelihoods ((Baro and Deubel, 2006; Barrett, 2002; Devereux and Sabates-Wheeler, 2004; Walker, 1989)). In many cases increases in food prices force those with insufficient incomes to ration as well.

Rationing may be seen as the initial response to food shortages at or near the onset of a famine. However, in many cases rationing is needed on a seasonal basis. This rationing is done at the level of households and communities. When the shortage becomes too severe, households may reduce future security by eating seeds or selling livestock, followed by severe illness, starvation and death if the shortages persist. While climate change may alter the frequency and severity of droughts, the causes of famine are multi-factoral and often lie in social, economic and political processes in addition to climatic variability ((Bohle *et al.*, 1994; Sen, 1981; Wisner *et al.*, 2004)).

Food rationing is unusual in developed countries where most communities are not based on subsistence production and welfare systems and NGO agencies respond to needs of those with livelihood deficits. However, other forms of rationing do exist particularly in response to drought events. Reductions in water use can be achieved through a number of measures including: metering, rationing (fixed amounts, proportional reductions, or voluntary reductions), pressure reduction, leakage reduction, conservation devices, education, plumbing codes, market mechanisms (e.g. transferable quotas, tariffs, pricing) and water-use restrictions ((Froukh, 2001; Lund and Reed, 1995)).

Electricity supplies may also be disrupted by disaster events resulting in partial or total blackouts. Such events cause considerable disruption to other services, domestic customers and to businesses. Rose *et al.* ((Rose *et al.*, 2007)) show that many American businesses can be quite resilient in such circumstances adapting a variety of strategies including conserving energy, using alternative forms of energy, using alternative forms of generation, rescheduling activities to a future date or focussing on the low or no energy elements of the business operation. Rose and Liao ((Rose and Liao, 2005)) had similar findings for water supply disruption. Electricity rationing may also be required when low precipitation reduces hydroelectricity production, a possible scenario in some places under some climate projections ((Boyd and Ibarrarán, 2009; Vörösmarty *et al.*, 2000)). In some cases there may be competition among a range of sectors including industry, agriculture, electricity production and domestic water supply ((Vörösmarty *et al.*, 2000)) that may have to be addressed through rationing and other measures such as those listed above. However, using fossil fuels to generate electricity as an alternative to hydro production may be considered a maladaptive option.

Other elements that may be rationed as a result of natural hazards or disasters include medical and health services (often referred to as triage) where disasters may simultaneously cause large a spike in numbers requiring medical assistance and a reduction in medical facilities, equipment, pharmaceuticals and personnel. Triage is a process of classifying patients and prioritizes those with the greatest need and the highest likelihood of a positive outcome. From this perspective triage seeks to achieve the best results for the largest number of people ((Alexander, 2002) (Iserson and Moskop, 2007)).

5.2.6. Migration and other Population Movements

Natural disasters are linked with population mobility in a number of ways. Evacuations (see 5.2.2.) occur before, during and after some disaster events. Longer-term relocation of affected communities sometimes occurs. Relocations can be both temporary (a few weeks to months), or longer, in which case they become permanent. These different forms of population movements have quite different implications for the communities concerned. They may also be differentiated on the basis of whether the mobility is voluntary or forced and whether or not international borders are crossed. Most contemporary research views population mobility as a continuum from completely voluntary movements to completely forced migrations ((Laczko, 2009)).

Community relocation schemes are those in which whole communities are relocated to a new non-exposed site. Perry and Lindell ((Perry and Lindell, 1997)) examine one such instance in Allenville, Arizona. They developed a set of five principles for achieving positive outcomes in relocation projects: 1) The community to be relocated should be organised; 2) All potential relocatees should be involved in the relocation decision-making process; 3) Citizens must understand the multi-organisational context in which the relocation is to be conducted; 4) Special attention should be given to the social and personal needs of the relocatees; and 5) Social networks need to be preserved ((Perry and Lindell, 1997)). For many communities relocation is difficult, especially in those communities with communal land ownership. In the Pacific Islands, for example, relocation within one's own lands is least disruptive but leaving it completely is much more difficult, as is making land available for people who have been relocated ((Campbell, 2010b)).

Where climate change increases the marginality of livelihoods and settlements beyond a sustainable level, communities may be forced to migrate. This may be caused by changing mean conditions or through changes in extreme events. Extremes often serve as precipitating events ((Hugo, 1996)). Myers' ((Myers, 2002)) prediction that there would be as many as 200 million environmentally forced migrants by mid 21[st] century has been widely reported. Brown ((Brown, 2008)) provides a range of estimates from an increase of five to ten per cent over current migration flows under a favourable projection upwards to a figure that may exceed Myer's prediction under the worst case scenario. These efforts to quantify climate migration do not distinguish the climatic causes of migration which typically has many causative factors ((Hugo, 1996)). Many researchers have raised doubts about such a magnitude of migration and many consider that climate related migration may not necessary be a problem and indeed may be a positive adaptive response ((Barnett and Webber, 2009)).

These figures are global estimations and provide little insight into the likely local implications of such large-scale migratory patterns. Migration will have local effects, not only for the communities generating the migrants, but those communities where they may settle. Barnett and Webber (2009) also note that the less voluntary the migration choice is, the more disruptive it will become. In the context of dam construction, for example Hwang *et al*. ((Hwang *et al*., 2007)) found that communities anticipating forced migration experienced stress. Hwang *et al*. ((Hwang *et al*., 2010)) also found that forced migration directly led to increased levels of depression and the weakening of social safeguards in the relocation process. One outcome of climate change may be that entire communities may be required to relocate and in some cases, such as those living in atoll countries, the relocation may have to be international. It is likely that such relocation will have significant social, cultural and psychological impacts ((Campbell, 2010b)).

5.2.7. Emergency Assistance and Disaster Relief

Relief often is unsuitable or inappropriate because people affected by disasters are not completely helpless or passive ((Cuny, 1983)(De Ville de Groyet, 2000)). This view is sustained by commonplace definitions of disasters as situations where communities or even countries cannot cope without external assistance ((Cuny, 1983)). In some cases, relief serves to remove agency from disaster 'victims' so that 'ownership' of the event and control over the recovery phase is lost at the local level ((Hillhorst, 2002)).

It is important to realise that the first actors providing assistance during and after disasters are members of the affected community ((De Ville de Groyet, 2000)). In isolated communities such as those in outer islands, external assistance may be subject to considerable delay and self-help is an important element of response. Typically, emergency assistance and disaster relief in developed countries comes in the form of assistance from national and state/provincial level governments to local communities. For developing countries international relief is more commonly distributed, although quite often heavy costs also fall on developing country governments. In all disasters initial assistance comes from local sources ((Development Initiatives, 2009)). International relief may come from a range of sources including multilateral institutions (common actors are UNOCHA, UNDP, WHO and UNICEF), bilateral arrangements, the International Federation of Red Cross and Red Crescent Societies, and numerous NGOs such as Oxfam, Save the Children Fund and the like ((Beamon and Balcik, 2008)). The disaster relief process has become highly sophisticated and much broader in scope over the past two decades and includes such things as assistance in post-disaster assessment, food provision, water and sanitation, medical assistance and health services, household goods, temporary shelter, transport, tools and equipment, security, logistics, communications and community services ((Cahill, 2007)(Bynander *et al*., 2005)).

Much disaster assistance takes place at the local level through local charities, kinship networks and local governments. There is also a considerable amount of relief that tends to be organised at more of a national and international scale than local scale, although distribution and use of relief occur at the local level. From this perspective it is vital to understand what is locally appropriate in terms of the type of relief provided, and how it is distributed ((Kovác and Spens, 2007)). Similarly, local resources and capacities should be utilised as much as possible (Beamon and Baclik, 2008). There has also been a recent trend towards international humanitarian organisations working with local partners, although this can result in the imposition of external cultural values resulting in resentment or resistance ((Hillhorst, 2002)).

While relief is often a critically important strategy for coping, there are problems associated with it. Relief can undermine local coping capacities and reduce resilience and sustainability ((Susman *et al*., 1983; Waddell, 1989)) and it may reinforce the status quo that was characterized by vulnerability ((O'Keefe *et al*., 1976)). Relief is often inequitably distributed and in some disasters there is insufficient relief. Corruption is also a factor in some disaster relief operations with local elites often benefiting more than others ((Pelling and Dill, 2010)).

Not all disasters engender the same response as local communities receive different levels of assistance. For example, those people most affected by a small event can suffer just as much as a globally publicised big event but are often overlooked by relief agencies. Fast onset and unusual disasters such as tsunamis generate much more public interest and contributions from governments, NGOs, and the public, sometimes referred to as the CNN factor ((Schmid, 1998){{}}). Disasters that are overshadowed by other newsworthy or media events, such as coverage of the Olympic Games, are often characterised by lower levels of relief support ((Eisensee and Stromberg, 2007)). Where there is widespread media coverage, NGOs and governments are often pressured to respond quickly with the possibility of an oversupply of relief and personnel. This has worsened in recent times when reporters are ‘parachuted’ into disaster sites often in advance of relief teams (who have more than a camera and satellite transmitter to transport and distribute) but who have little understanding of the contextual factors that often underlie vulnerability to disasters ((Silk, 2000)). Such media coverage often perpetrates disaster myths such as the prevalence of looting, helplessness and social collapse putting pressure on interveners to select military options for relief when humanitarian assistance would be more helpful ((Tierney *et al*., 2006)).

Relief is politically more appealing than disaster risk reduction (DRR) ((Seck, 2007)) and it often gains much greater political support and funding than measures that would help offset the need for it in the first place. Providing relief reflects well on politicians (both in donor and recipient countries) who are seen to be caring, and taking action, and responding to public demand ((Eisensee and Stromberg, 2007)).

Major shares of the costs of disaster relief and recovery still fall on the governments of disaster affected countries. Bilateral relief is often tied and is limited to materials from donor countries and most relief is subject to relatively strict criteria to reduce perceived levels of corruption. In both of these cases flexibility is heavily restricted. Relief can also produce local economic distortions such as causing shops to lose business as the market becomes flooded with relief supplies. At the same time, there is the view that disaster relief can create a culture of dependency and expectation at the local level ((Burby, 2006)), where disaster relief becomes viewed as an entitlement program as local communities are not forced to bear the responsibility for their own locational choices, land use, and lack of mitigation practices.

5.3. Community-Based Risk Management in a Changing Climate

Community-based risk management has traditionally dealt with climate events without considering the long-term trajectories presented by a changing climate. This section provides examples of adaptations to disaster risk and how such proactive behaviors at the community level by local government and NGOs can provide guidance for reducing the longer term impacts of climate change. Although reacting to extreme events and their impacts is important, it is crucial to focus on building the resilience of communities, cities and sectors in order to ameliorate the impacts of extreme events now and into the future.

5.3.1. Local Climate Extremes

Local communities routinely experience natural hazards many from climate-related events (see Chapter 3). Drought has affected local communities from Africa to the Americas, to Australia and New Zealand. Tropical and extra-tropical windstorms are seasonal events for many regions. A compendium of extreme hazard events related to climate illustrates the pervasive nature of hazards on communities, according to one data source (see Table 5-2). All regions and many of the local communities within them have experienced a disaster event (defined by thresholds of more than 10 people killed or 100 affected, or a call for international assistance, or a declaration of a state of emergency) during the past decade. Flooding and windstorms (cyclones and hurricanes) are among the most prevalent, with the impacts measured in economic losses as well as human losses (see Table 5-3). However, local communities routinely experience hazards that do not rise to the same level of impact as a disaster. These include snow and ice events; severe storms, flooding, and hail events. Heat waves and wildfires are more frequent events in the northern latitudes ((Alcamo *et al*., 2007); (Field *et al*., 2007)). More intense rainfall producing flooding and mud slides in mountainous are becoming the norm rather than the exception in many parts of the world ((Solomon *et al*., 2007)). Communities affected by drought persist in Africa, India, and China. Coastal communities worldwide are experiencing more erosion due to stronger storms. What is now different is that these hazards are relatively new for many communities. For example, Hurricane Catarina, the first South Atlantic hurricane which made landfall as a category 1 storm just north of Porto Alegre, Brazil, in March 2004 ((McTaggart-Cowan *et al*., 2006)), the region's first local experience with a hurricane.

[INSERT TABLE 5-2 HERE:
Table 5-2: Local experience with climate extreme hazards based on number of reported disasters, 1999-2008.]

[INSERT TABLE 5-3 HERE:
Table 5-3: Top five climate extreme hazards events, 1950-2009.]

5.3.2. Assessing Coping in Light of Disaster Risk Management: What Leads to Proactive Behaviors?

Capacity investments necessarily involve decisions based on prior disaster experiences and future disaster expectations, including those related to emergency response and disaster recovery. Birkland ((Birkland, 1997), Pulwarty and Melis ((Pulwarty and Melis, 2001)) and others, have identified some of the physical and social characteristics that allow for the prior adoption of effective partnerships and implementation practices during events. These include the occurrence of previous strong focusing events (such as catastrophic extreme events) that generate significant public interest and the personal attention of key leaders, a social basis for cooperation including close inter-jurisdictional partnerships, and the existence of a supported collaborative framework between research and management. Although loss of life from natural hazards has been declining, the property and livelihood losses from those causes have been increasing. Factors conditioning this outcome have been be summed up by Burton *et al*. ((Burton *et al*., 2001)) as "knowing better and losing even more". For instance researchers have understood the consequences of a major hurricane hitting New Orleans with a fairly detailed understanding of planning and response needs. This knowledge appears to have been ignored at all levels of government including the local level ((Kates *et al*., 2006)). Burton *et al*. ((Burton *et al*., 2001)) offer four explanations for why such conditions exist from an information standpoint: 1) knowledge continues to be flawed by areas of ignorance; 2) knowledge is available but not used effectively; 3) knowledge is used effectively but takes a long time to have an impact; and 4) knowledge is used effectively in some respects but is overwhelmed by increases in vulnerability and in population, wealth, and poverty.

The impacts and changes that some focusing events engender can only defined retrospectively ((Barton, 1969; Barton, 2005; Fritz, 1961; Turner, 1978)). For example, a 30-year drought-induced famine ultimately becomes defined as a multiple disaster. Such a disaster exists in social time only when changing historical conditions over decades have been collectively reconstructed to define them as acute. Individuals can make choices to reduce their risk but social relations, context, and certain structural features of the society in which they live and work mediate these choices and their effects. A growing acknowledgement that aid cannot cover more than a small fraction of the costs of disasters is leading to new approaches, priorities and institutional configurations. The realization that dealing with risk and insecurity is a central part of how poor people develop their livelihood strategies has begun to position disaster mitigation and preparedness within many poverty alleviation agendas ((Olshansky and Kartez, 1998)(Cuny, 1983; UNISDR, 2009)). A number of long-standing challenges remain as the larger and looser coalitions of interests that sometimes emerge after great catastrophes rarely last long enough to sustain the kind of efforts needed to reduce hazards and disaster risk.

Another pro-active behavior is the use of spatial hazard information by planners. However, such us is likely only if the information is clearly mapped, comes from an authoritative source and provides specific guidelines for action and ease of implementation, and the community is provided with evidence that the approaches have worked in other places ((Olshansky and Kartez, 1998)). Berke and Beatley ((Berke and Beatley, 1992)) examined a range of hazard mitigation measures and ranked them according to effectiveness and ease of enforcement. The most effective measures are land acquisition, density reduction, clustering of development, building codes for new construction, and mandatory retrofit of existing structures. The high costs land acquisition programs can make them unattractive to small communities (see 5.2.4). There has been limited systematic scientific characterization of the ways in which different hazard agents vary in their threats and characteristics and, thus, requiring different pre-impact interventions and post-impact responses by households, businesses, and community hazard management organizations.

Short-term risk reduction strategies can actually produce greater vulnerability to future events as shown in diverse contexts such as ENSO-related impacts in Latin America, induced development below dams or levees in the U.S., and flooding in the UK ((Bowden, 1981)(Berube and Katz, 2005; Penning-Rowsell *et al*., 2006; Pulwarty *et al*., 2004)). One important finding about community protection works such as dams and levees is that they are commonly misperceived as providing complete protection, so they actually increase development—and thus vulnerability—in hazard-prone areas ((Burby, 2006)). A more general statement of this proposition is found in the safe development paradox in which increased safety induces increased development leading to increased losses. The conflicting policy goals of rapid recovery, safety, betterment, and equity and their relative strengths and weaknesses largely reflect experience with large disasters in other places and times. The actual decisions and rebuilding undertaken to date clearly demonstrate the rush by government at all levels and the residents themselves to rebuild the familiar ((Kates *et al*., 2006)). Similarly, in drought prone areas provision of assured water supplies encourages the development of intensive agricultural systems – and for that matter, domestic water use habits – that are poorly suited to the inherent variability of supply and will be even more so in areas projected to become increasingly arid in a changing climate.

Burby and May *et al*. ((Burby *et al*., 1997)) have found evidence for some communities that previous occurrence of a disaster did not have a strong effect on the number of hazard mitigation techniques subsequently employed. Agendas are unstable over time and disasters can affect them by serving as focusing events ((Anderson, 1994; Birkland, 1997; Kingdon, 1984)), concentrating public and official attention for a certain time, resulting in a window of opportunity.

On the other hand, extreme events have been identified as offering “windows of opportunity” for including both retrofitting and long term risk reduction plans, such as for climate change adaptation, after particularly severe or visible events such as Hurricane Katrina or severe, sustained drought. A policy window opens when the opportunity arises to change policy direction and is thus an important part of agenda setting ((Anderson, 1994; Kingdon, 1984)). Policy windows can be created by triggering or focusing events, such as disasters, as well as by changes in government and shifts in public opinion. Immediately following a disaster, the political climate may be conducive to much needed legal, economic and social change which can begin to reduce structural vulnerabilities, for example in such areas as mainstreaming gender issues, land reform, skills development, employment, housing and social solidarity. The assumptions behind the utility of policy windows are that: 1) new awareness of risks after a disaster leads to broad consensus; 2) development and humanitarian agencies are 'reminded' of disaster risks; and 3) enhanced political will and resources become available ((Christoplos, 2006; Michaels *et al*., 2006)). However, during the post-recovery phase, reconstruction requires weighing, prioritizing, and sequencing of policy programming, and there are multiple sometimes competing mainstreaming agendas for most decision-makers and operational actors to digest with attendant lobbying for resources for various actions. The most significant is the pressure to quickly return to conditions prior to the event rather than incorporate longer term development policies ((Christoplos, 2006; Kates *et al*., 2006)). How long such a window will stay open or precisely what factors will make it close under a given set of conditions is not well-known, even though 3-6 months has been recognized in specific cases ((Kates *et al*., 2006)).

The active participation of women has been shown to increase the effectiveness of prevention, disaster relief, reconstruction and transformation of communities ((Enarson and Morrow, 1997)) (see Box 5-4). There is also research which suggests that children can be effective conveyors of risk information and become active agents for building preparedness and resilience to disasters and climate change, but such a role has been neglected or underestimated ((Bartlett, 2008; Manyena *et al*., 2008; Mitchell *et al*., 2008; Peek, 2008)).

_____ START BOX 5-4 HERE _____

Box 5-4. The Role of Women in Proactive Behavior

Women's involvement in running shelters and processing food was crucial to the recovery of families and communities after Hurricane Mitch hit Honduras. A third of the shelters were run by women, and this figure rose to 42% in the capital. The municipality of La Masica in Honduras, with a mostly rural population of 24,336 people, stands out in the aftermath of Mitch because, unlike other municipalities in the northern Atlanta Department, it reported no mortality. This outcome can be directly attributed to a process of community emergency preparedness that began about six months prior to the disaster, Gender lectures were given and, consequently, the community decided that men and women should participate equally in all hazard management activities. When Mitch struck, the municipality was prepared and vacated the area promptly, thus avoiding deaths. Women participated actively in all relief operations. They went on rescue missions, rehabilitated local infrastructure (such as schools), and along with men, distributed food. They also took over from men who had abandoned the task of continuous monitoring of the early warning system. The experience shows that preparedness is an important step in saving lives. The incorporation of women from the start, on an equal footing with men, contributed to the success in saving lives ((Enarson and Morrow, 1997))**.**

_____ END BOX 5-4 HERE _____

5.3.3. Basic Development and Human Security

The physical trends and changing patterns in the climate are projected to increase in the future in terms of intensity and frequency leading to more frequent and severe climatic events (see Chapter 3). Developing countries including LDCs and SIDS are generally characterized by certain socio-economic trends high rates of population growth (especially in hazard prone areas); urbanization; food insecurity; high levels of poverty; conflicts; and mismanagement of natural resources) that render them more vulnerable to the impacts of climate change (Chapter 2). For the LDCs in Africa and Asia, climate change is expected to result in flooding of low-lying coastal areas, increased water scarcity, decline in agricultural yields and fisheries resources, and loss of biological resources (Osman-Elasha and Downing, 2007)). People exposed to the most severe climate-related hazards are often those least able to cope with the associated impacts, due to their limited adaptive capacity; a situation that is likely to impose additional threats to economic development, efforts to reduce poverty and achieve the Millennium Development Goals ((Stern, 2007; UNDP, 2007)). Similar to droughts, floods have a significant impact on African development as recurrent floods in some countries are linked with El Niño-Southern Oscillation (ENSO) events resulting in major economic and human losses in e.g. Mozambique ((Mirza, 2003); (Obasi, 2005)) and Somalia ((Kabat *et al*., 2002)). The impacts of droughts and floods are often further exacerbated by health problems, such as diarrhea, cholera and malaria ((Kabat *et al*., 2002)).

Climate change effects will not happen in hypothetical scenarios, but in local territories where many hazards already occur and where ecosystems and communities are already facing multiple risks. It is possible that some new and unknown hazards may appear, but in most cases climate change will make the existing hazards more complex and harmful ((Parry *et al*., 2007; Solomon *et al*., 2007)). For example, in places already affected by crisis situations such as political violence producing trans-border refugees as well as internally displaced people, climate change may exacerbate the situation. Climate change causes environmental stress and is therefore is a potential cause of conflict along with local unsustainable behavior ((Osman-Elasha, 2008)). Environmental stress feeds the tensions between communities as they compete for land to support their livelihoods ((Barnett, 2001; Kates, 2000; Osman-Elasha and El Sanjak, 2009)). Such complex relations can easily lead to a vicious circle of deprivation with more and more displaced people, new and added pressures on the environment, leading to its deterioration and ultimately the destruction of livelihoods, and increasing conflict.

The effective reduction of vulnerabilities to current natural hazards and to climate change requires coordination across different levels and sectors and the involvement of a broad range of stakeholders beginning at the local level ((Devereux and Coll-Black, 2007; DFID, 2006; UNISDR, 2004)). To strengthen the link between disaster risk management and adaptation to climate change, it is important to understand when, and at what level, coordination is required, and who should take the lead ((Mitchell and Van Aalst, 2008)). Many adaptation strategies, such as large-scale agriculture, irrigation and hydroelectric development, will benefit large groups or the national interests but they may harm local, indigenous and poor populations ((Kates, 2000)(Kates, 2000)). Therefore, any new disaster reduction or climate change adaptation strategies must be build on strengthening local actors and enhancing their livelihoods ((Osman-Elasha, 2006a)). It is equally important to identify the differentiated social impacts of climate change based on gender, age, disability, ethnicity, geographical location, livelihood, and migrant status ((Tanner and Mitchell, 2008)). The problem is in identifying those adaptations that favor these most vulnerable groups, and to address these problems using an integrated management approach, with different stakeholders ((Sperling and Szekely, 2005)). Win-win solutions are unlikely with climate change, as there will always be winners and losers from extreme events ((Adger, 2001)). It is increasingly recognized that adaptation and DRR must be integral components of development planning and implementation, to increase sustainability ((Thomalla *et al*., 2006)). In other words, adaptation and DRR should be mainstreamed into national development plans, poverty reduction strategies, sectoral policies and other development tools and techniques ((UNDP, 2007)). Efforts to forge greater and more equitable capacity at the local scale have to be supported by policies at the national level to increase the ability of local institutions and communities to cope with present and future risks from climate-sensitive hazards ((Tearfund., 2006)).

5.3.4. Recovery and Reconstruction Post Event

Recovery and reconstruction include actions that seek to establish ‘everyday life’ of the community affected by disaster ((Hewitt, 1997)). Often reconstruction enables communities to return to the same conditions that existed prior to the disaster, and in so doing create the potential for further similar losses, thus reproducing the same exposure that resulted in disaster in the first place ((Jha *et al*., 2010)). There are a number of obstacles to effective and timely reconstruction including lack of labour, lack of capacity among local construction companies, material shortages, resolution of land tenure considerations, and insufficiency of funds ((Keraminiyage *et al*., 2008)). While there is urgency to have people re-housed and livelihoods re-established, long-term benefits may be gained through carefully implemented reconstruction ((Hallegatte and Dumas, 2009)(Hallegatte, 2008)).

Recovery and reconstruction (especially housing rehabilitation and rebuilding) are among the more contentious elements of disaster response. One of the major issues surrounding recovery in the scientific literature is the lack of clarity between recovery as a process and recovery as an outcome. The former emphasizes betterment processes where pre-existing vulnerability issues are addressed. The latter focuses on the material manifestation of recovery such as building houses or infrastructure. Often following large disasters large-scale top down programmes result in rebuilding houses but failing to provide homes ((Petal *et al*., 2008)). Moreover, haste in reconstruction, while achieving short-term objectives, often results in unsustainable outcomes and increasing vulnerability ((Ingram *et al*., 2006)I(Ingram *et al*., 2006)). As seen in the aftermath of Hurricane Katrina, there are measureable local disparities in recovery, leading to questions of recovery for whom and recovery to what ((Curtis *et al*., 2010; Finch *et al*., 2010; Stevenson *et al*., 2010)).

Most reporting on recovery and reconstruction has tended to focus on housing and the so-called lifelines of infrastructure: electricity, water supply and transport links. However, equally important, if indeed not more so, is the rehabilitation of livelihoods, especially in developing countries. Accordingly, it is important to include those climate related disaster events, such as droughts, that don't just destroy the built environment in evaluating recovery and reconstruction. Indeed post-disaster recovery that takes the need to re-establish livelihoods, in particular sustainable, livelihoods is an important aspect of disaster risk reduction and development ((Nakagawa and Shaw, 2004)).

As with relief, major problems occur where planning and implementation of recovery and reconstruction is taken from the hands of the local communities concerned. Moreover, the use of inappropriate (culturally, socially or environmentally) materials and techniques may render rebuilt houses as unsuitable for their occupants ((Jha *et al*., 2010)). However, as Davidson *et al*. ((Davidson *et al*., 2007)) found, this is often the case and results in local community members having little involvement in decision making and being; instead they are used to provide labor. It is also important to acknowledge that post-disaster recovery often does not reach all community members and in many recovery programmes, the most vulnerable, those who have suffered the greatest losses, often do not recover from disasters, and endure long-term hardship (Wisner *et al*., 2004: 358).

Post-disaster rehabilitation provides a critical opportunity for reducing risk in the face of further events. In reconstructing livelihoods damaged or destroyed by disaster it is important to take into account the diversity of livelihoods in many communities, to work with community members to develop strategies and to work towards producing sustainable livelihoods that are likely to be more resilient in the face of future events ((Pomeroy *et al*., 2006)).

5.3.5. Components of Risk Management and Climate Adaptation

There are many different components to risk management and climate adaptation. Each presents a unique set of opportunities and challenges for disaster risk management and climate adaptation. This section covers some of the most important locally-based components including anticipating risks, communicating risk information, empowerment and leadership, social drivers, integrating risk knowledge into practice, and local government initiatives and practices.

5.*3.5.1. Anticipate Risks in a Climate Change Context*

Climate change presents a challenge for existing good practice of disaster risk reduction because it introduces changes in climate risks over time. In order to anticipate the risks and surprise associated with climate change there are two emerging responses at the local level. The first is to integrate information about changing climate risks into disaster planning and the second is to focus on community-based adaptation (CBA), where the effected community helps to define solutions for managing risks whilst considering climate change.

Contextualizing disaster response within a climate change continuum requires information and knowledge about both slow and fast onset events ((Ensor and Berger, 2009)) . Weather information is critical for responding to flashfloods and cyclones, seasonal climate information can help to respond to drought and above normal rainfall predictions and longer-term decadal forecasts can help to understand shifts in the seasons. Although early warning systems that draw on weather information have been used to manage disasters, there has not been much experience in using seasonal climate forecast information to prepare for extreme events although there is experience on using seasonal forecasts as a means for dealing with annual variability that is expected to shift with climate change (see

Box 5-5) ((Hellmuth *et al*., 2007)(Patt *et al*., 2009)). A response by the IFRC in the West/Central Africa Zone (WCAZ) shows how they issued the first emergency appeal based on a seasonal forecast of expected intense rainfall and pre-positioned relief items, developed flood contingency plans and launched pre-emergency funding requests (((IFRC),International Federation of the Red Cross and Red Crescent Societies, 2009; Suarez, 2009)). Setting up plans in advance enabled communication systems to be strengthened before the extreme event struck, so that when it did information was passed from national headquarters to regional focal points, to the districts, to community leaders and on to communities (((IFRC),International Federation of the Red Cross and Red Crescent Societies, 2009)).

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Box 5-5. Case Study – Small-Scale Farmers Adapting to Climate Change (Northern Cape, South Africa): Taking Collective Action to Improve Livelihoods Strategies

The Northern Cape Province, South Africa, is a harsh landscape, with frequent and severe droughts and extreme conditions for the people, animals and plants living there. This has long had a negative impact on small-scale rooibos farmers living in some of the more marginal production areas. Rooibos is an indigenous crop that is well adapted to the prevailing hot, dry summer conditions, but is sensitive to prolonged drought. Rooibos tea has become well-accepted on world markets, but this success has brought little improvement to marginalised small-scale producers.

In 2001 a small group of farmers decided to take collaborative action to improve their livelihoods and founded the Heiveld Co-operative Ltd. Initially established as a trading co-operative to help the farmers produce and market their tea jointly, it subsequently became apparent that the local organisation was also an important vehicle for social change in the wider community ((Oettlé *et al*., 2004)). The Heiveld became a repository and source of local and scientific knowledge related to sustainable rooibos production.

Adaptation that builds on local knowledge, responds to local conditions and is driven by the positive energy of affected communities creates sustained resilience in the face of environmental, economic and social change. Local capacities have been strengthened, and the local organisation (the Heiveld Co-operative) has been able to expand its networks – an important and necessary aspect of increasing resilience in challenging times.

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In order to strengthen the integration of climate information at the local level, better systems are necessary. A systematic restructuring is needed in order for the humanitarian community to absorb and act on climate information that is currently available ((Suarez, 2009)). Part of the challenge is in translating output from climate change scenarios and seasonal climate forecasts into decisions on whether humanitarian organizations should act or not. Climate information has a complex set of data including figures, tables and technical statements, yet at the local level organisations determine their response if probability of the hazard is high enough and if too many people are at risk. Communication strategies are needed to ensure that climate information about impending threats can be synthesized and translated into decisions and actions ((Suarez, 2009)).

The second response to strengthening community-based disaster risk management in a climate change context has been to focus on community-based adaptation (CBA), where the community is involved in deciding how they want to prepare for climate risks and coordinate community action to achieve adaptation to climate change ((Ebi, 2008)). Part of this entails community risk assessment (CRA) for climate change adaptation that assesses the hazards, vulnerabilities and capacities of the community ((Van Aalst *et al*., 2008)), which has also been called community based disaster preparedness (CBDP) among other names ((Allen, 2006)). The intention is to foster active participation in collecting information that is rooted in the communities and enables affected people to participate in their own recovery through enhancing resilience by strengthening social-institutional measures including social relations ((Allen, 2006)). In assessing short and long term climate risks, the input from and needs of vulnerable groups are often excluded, which is clearly seen in the NAPAs where the urban poor seldom feature ((Douglas *et al*., 2009)). The tools for engaging vulnerable groups in the process include transect walks and risk maps that capture the climate related hazards and risks ((Van Aalst *et al*., 2008)) and storylines about possible future climate change impacts ((Ebi, 2008)), although these tools often require input from participants external to the community with long-term climate information ((Van Aalst *et al*., 2008)).

The challenges in using community-based adaptation approaches include the challenge of scaling up information, the fact that it is resource-intensive ((Van Aalst *et al*., 2008; Van Aalst *et al*., 2008)) and that unintended disempowerment does occur at times ((Allen, 2006)). The integration of climate change information increases this challenge as it introduces an additional layer of uncertainty ((Allen, 2006)) and may conflict with the principle of keeping CBA simple ((Van Aalst *et al*., 2008)). There is little evidence that secondary data on climate change has been used in CBA, partly because of the challenge of limited access to downscaled climate change scenarios relevant at the local level ((Ziervogel and Zermoglio, 2009)) and because of the uncertainty of projections.

Examples of CBA illustrate some of the processes involved. In northern Bangladesh, a Practical Action flooding adaptation project helped to establish early warning committees within villages that linked to organizations outside the community, with which they did not usually interact and that have historically blocked collective action and resource distribution ((Ensor and Berger, 2009)). Through this revised governance structure the building of small roads, digging culverts and planting trees to alleviate flood impacts was facilitated. In Portland, Oregon, the City Repair project engaged a range of actors to reduce the impact of urban heat islands through engaging neighborhoods and linking them to experts to install green roofs, urban vegetation and fountains that simultaneously increased a sense of ownership in the improvements ((Ebi, 2008)(Ebi, 2008)). In the Philippines, the CBDP approach enabled a deeper understanding of local-specific vulnerability than previous disaster management contexts, which they argue is critical because of the diverse impacts of climate change as compared to isolated disaster events ((Allen, 2006)). However, these community-based approaches should be viewed as part of a wider system that addresses multiple scales.

Under climate change, CBA responses are likely to be beneficial and need increased support). The need for coordinated collective action was seen in Kampala, where land cover change and changing climate is increasing the frequency and severity of urban flooding ((Douglas *et al*., 2009)). Existing activities were uncoordinated although some collective action was undertaken to clear drainage channels. However, residents felt that much could be done to adapt to frequent flooding including increasing awareness of roles and responsibilities in averting floods, improving the drainage system, garbage and solid waste disposal as well as strengthening the building inspection unit and enforcing bylaws on the construction of houses and sanitation facilities. Similarly, in Accra, residents felt that municipal laws on planning and urban design need to be enforced suggesting that strong links are needed between community responses and municipal responses.

5.3.5.2. Communicating Disaster Risk

Both anticipating and responding to risk entails communications between communities, public officials, and experts (see 5.2.1). However, communicating the extreme impacts of climate change presents an important and difficult challenge ((Moser and Dilling, 2007)). A burgeoning field of research explores the barriers to communicating the impacts of climate change to motivate constructive behaviors and policy choices ((Frumkin and McMichael, 2008)). Research has shown that when delivering messages, those targeted to specific audiences are more likely to be effective ((Maibach *et al*., 2008)). In addition, communication is likely to be more effective when the information regarding risk does not exceed the capacity for coping and therefore galvanizes resilience ((Fritze *et al*., 2008)). Some research has suggested that a focus on personal risk of specific damages of climate change is a central element in motivating interest and behavior change ((Leiserowitz, 2007)). In addition, indicating threats to future generations may generate more concern than mentioning other climate change impacts ((Maibach *et al*., 2008)(Maibach *et al*., 2008)).

The characteristics of messages within risk communications that have a significant impact on local adoption of adjustments involve information quality (specificity, consistency, and source certainty) and information reinforcement (number of warnings) (; (Mileti and O'Brien, 1992; Mileti and Fitzpatrick, 1993; O'Brien and Mileti, 1992)). As used here, the term *risk communication* refers to intentional efforts on the part of one or more sources (e.g., international agencies, national governments, local government) to provide information about hazards and hazard adjustments through a variety of channels to different audience segments (e.g., the general public, specific at-risk communities). Researchers have long recognized different sources as being peers (friends, relatives, neighbors, and coworkers), news media, and/or authorities ((Drabek, 1986)). These sources systematically differ in terms of such characteristics as perceived expertise, trustworthiness, and protection responsibility ((Lindell and Perry, 1992; Lindell and Whitney, 2000; Pulwarty, 2007)). Risk area residents use channels for different purposes: the internet, radio and television are useful for immediate updates; meetings are useful for clarifying questions; and newspapers and brochures are useful for retaining information that might be needed later.

Risk messages also vary in threat specificity, guidance specificity, repetition, consistency, certainty, clarity, accuracy, and sufficiency ((Lindell and Perry, 2004; Mileti and Sorensen, 1990; Mileti and Peek, 2002)). The need to understand the usability of scientific information, especially at the local level, has received much attention from a communications perspective but little from an organizational perspective. There has been little systematic investigation, for example, on message effectiveness in prompting action based on differing characteristics such as the precision of message dissemination, penetration into normal activities, message specificity, message distortion, rate of dissemination over time, receiver characteristics, sender requirements, and feedback ((Lindell and Perry, 1992; NRC (National Research Council), 2006)). Receiver characteristics include previous hazard experience, preexisting beliefs about the hazard and protective actions, and personality traits. In addition, demographic characteristics—such as gender, age, education, income, ethnicity, marital status, and family size play strong roles. Within several countries (Lesotho, Mozambique and Swaziland) it was found that timely issuance remains a key weakness in climate information systems especially for communication passed on to communities from the national early warning units. There was also too much reliance on one-way devices for communication (such as the radio), which were felt to be inadequate for agricultural applications (for example, farmers are not able to ask further questions regarding the information provided) ((Ziervogel, 2004)). Within many rural communities, low bandwidth and poor computing infrastructure pose serious constraints to risk message receipt.

The degree of acceptability of information and trust in the providers, dictate the context of communicating climate information (see Box 5-6). Lindell and Perry ((Lindell and Perry, 2004)4) summarized the available research as indicating message effects include pre-decisional processes (reception, attention, and comprehension). Several studies have identified the characteristics of pre-decisional practices that lead to effective communication over the long-term ((Cutter, 2001; Fischoff, 1992; Pulwarty, 2007)). These include: 1) Understanding of the goals, objectives, and constraints of communities in the target system; 2) Mapping practical pathways to different outcomes can be carried out as a co-production strategy among research, extension and farmer communities; 3) Bringing the delivery persons (e.g. extension personnel), research community etc.) to an understanding of what has to be done to translate current information into usable information; 4) Interacting with actual and potential users to better understand informational needs, desired formats of information, timeliness of delivery etc.; 5) Assessing impediments and opportunities to the flow of information including issues of credibility, legitimacy, compatibility (appropriate scale, content, match with existing practice) and acceptability; and 6) Relying on existing stakeholders' networks and organizations to disseminate and assess climate information and forecasts.

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Box 5-6. Successful Communication of Local Risk-Based Climate Information

The following questions have been identified as shaping the successful communication of risk-based climate information ((Ascher, 1978; Fischoff, 1992; Pulwarty, 2003)).

What do people already know and believe about the risks being posed?
What has been the past experience/outcomes of information use?
Is the new information *relevant* for decisions in the particular community?
Are the sources/providers of information *credible* to the intended user?
Are practitioners (e.g. farmers) *receptive* to the information and to research?
Is the information *accessible* to the decision maker?
Is the information *compatible* with existing decision models e.g. for farming practice?

Does the community (or individuals in the community) have the *capacity* to use information?

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Communications that include social, interpersonal, physical environmental, and policy factors can foster civic engagement and social change fundamental to reducing risk ((Brulle, 2010). A participatory approach highlights the need for two-way communication that engenders credibility, trust and cooperation ((NRC (National Research Council), 1989)(Frumkin and McMichael, 2008)), which are especially important in high-stress situations such as extreme impacts of climate change ((NRC (National Research Council), 1989)). For example, participatory video production is effective in communicating the extreme impacts of climate change ((Suarez *et al*., 2008)). Participatory video involves a community or group in creating their own videos through story-boarding and production ((Lunch, N. and Lunch, C., 2006)). Such projects are traditionally used in contexts, such as poor communities, where there are constraints to accurate climate information ((Patt and Gawa, 2002)). Engaging with community leaders or opinions leaders in accessing social networks through which to distribute information is another approach, traditionally used by health educators but also applicable to the translation of climate risks in a community context ((Maibach *et al*., 2008)). These types of communication projects can motivate community action necessary to promote preparedness ((Jacobs *et al*., 2009; Semenza, 2005)).

Visualizing methods such as mapping, cartographic animations, and graphic representations are also used to engage with stakeholders who may be impacted by extreme events ((Shaw *et al*., 2009)). Many programs are developing ways to use visualizations to help decision-makers adapt to a changing environment, suggesting that such tools can increase climate literacy ((Niepold *et al*., 2008)). Visualizations can be powerful tools, but issues of validity, subjectivity, and interpretation must be seriously considered in such work ((Nicholson-Cole, 2004)). These communications are most effective when they take local experiences or points of view and locally-relevant places into account ((O'Neill and Ebi, 2009)). Little evaluation has been done of visualization projects, therefore leaving a gap in understanding of how to most effectively communicate future risks of extreme events.

Part of the research gap regarding communication stems from the lack of communication projects that can be tested and shown to affect preparedness. On the most basic level, there is considerable understanding of the information needed for preparing for disasters, but less specific understanding of what information is necessary to generate community preparedness for climate change ((Fischhoff, 2007)). As observed by Finan ((Finan and Nelson, 2001)), the very discussion of climate forecasts and projections within potentially impacted communities has served as a vehicle for democratizing the drought discourse in Ceará (Northeast Brazil). Developing a seamless continuum across emergency responses, preparedness, and coping and adaptation requires insight into the demands that different types of disasters will place upon the community and the need to perform basic emergency functions--pre-event assessments, proactive hazards mitigation, incident management ((Lindell and Perry, 1996)). Preparing for short-term disasters enhances the capacity to adapt to longer term climate change.

5.3.5.3. Community Empowerment and Leadership

A critical factor in community based disaster risk reduction is that community members are empowered to take control of the processes involved. Marginalization ((Adger and Kelly, 1999); (Polack, 2008)(Mustafa, 1998)) and disempowerment ((Hewitt, 1997); (Mustafa, 1998)) are critical factors in creating vulnerability and efforts to reduce these characteristics play an important role in building resilient communities. Empowerment refers to giving community members control over their lives with support from outside ((Sagala *et al*., 2009)). This requires external facilitators to respect community structures, traditional and local knowledge systems, to assist but not take a dominating role, to share knowledge and to learn from community members ((Petal *et al*., 2008)). A key element in empowering communities is building trust between the community and the external facilitators ((Sagala *et al*., 2009)). It is also important to note that communities have choices from a range of disaster management options ((Mercer *et al*., 2008)). Empowerment in community based disaster risk management may also be applied to groups within communities whose voice may otherwise not be heard or who are in greater positions of vulnerability ((Wisner *et al*., 2004)). These include women ((Bari, 1998); (Clifton and Gell, 2001); (Polack, 2008)(Wiest *et al*., 1994)) and disabled people ((Wisner, 2002)).

Another key element of empowerment is ownership of the issue ((Buvinić *et al*., 1999)). This applies to all aspects of disaster management, from the ownership of a disaster itself so that the community has control of relief and reconstruction, to a local project to improve preparedness. Empowerment and ownership ensure that local needs are met, that community cohesion is sustained and a greater chance of success of the disaster management process.

5.3.5.4. Social Drivers

Localized social norms, social capital, and social networks shape behaviors and actions before, during, and after extreme events. Each of these factors both operates on their own and in some cases also intersects with the others. As vulnerability to disasters and climate change is socially-constructed (Chapter 2) ((Adger and Kelly, 1999)), the breakdown of collective action often leads to increased vulnerability. For example, coastal Northern Vietnam's institutional breakdown due to its economic transition has led to greater vulnerability to climate extremes ((Adger, 1999)).

Social norms are rules and patterns of behavior that reflect expectations of a particular social group ((Horne, 2001)). Norms structure many different kinds of action regarding climate change ((Pettenger, 2007)). Norms are embedded in formal institutional responses, as well as to smaller, informal groups that encounter disasters ((Raschky, 2008)). Norms of reciprocity, trust, and associations that bridge social divisions are a central part of social cohesion that fosters community capacity ((Kawachi and Berkman, 2000)). In the occurrence of extreme events, affected groups interact with one another in an attempt to develop a set of norms appropriate to the situation, otherwise known as emergent norm theory of collective behavior ((NRC (National Research Council), 2006)). This is true of those first affected at the local level whose norms and related social capital affect capacity for response ((Dolan and Walker, 2004)).

Social capital is a multifaceted concept that captures a variety of social engagement within the community that bonds people and generates a positive collective value. It is suggested as an important element in the face of climate extremes because community social resources such as networks, social obligations, trust, and shared expectations create social capital to prevent, prepare, and cope with disasters ((Dynes, 2006)). In climate change adaptation, scholars and policymakers increasingly promote social capital as a long-term adaptation strategy ((Adger, 2003; Pelling and High, 2005)). Social capital, however, can be driven by internal social networks and is oftentimes a function of the extent of community know-how and networks, which could become self-referential and insular ((Dale and Newman, 2010; Portes and Landolt, 1996)). This results in a closed society that lacks of innovation and diversity essential for climate change adaptation. Disaster itself is overwhelming, and can lead to the erosion of social capital and the demise of the community ((Ritchie and Gill, 2007)). This invites external engagement beyond local-level treatment of the disaster and extreme events ((Brondizio *et al*., 2009)(Cheong, 2010)). The inflow of external aids, expertise, and the emergence of new groups to cope with disaster are indicative of the necessity of bridging and linking social capital beyond local boundaries.

Social capital is embedded in social networks ((Lin, 2001)), or the social structure composed of individuals and organizations through multiple types of dependency, such as kinship, financial exchange, or prestige ((Wellman and Berkowitz, 1988)). Social networks provide a diversity of functions, such as facilitate sharing of expertise and resources across stakeholders ((Crabbé, 2006)). Networks can function to promote messages within communities through preventive advocacy, or the engagement of advocates in promoting preventive behavior ((Weibel, 1988)(Weibel, 1988)). Information about health risks has often been effectively distributed through a social network structure using opinion leaders as a guide ((Valente and Davis, 1999; Valente *et al*., 2003)), and has promising application for changing behavior regarding climate adaptation ((Maibach *et al*., 2008)). It is important to note that more potential has been shown in influencing behavior through community-level interventions than through individual-level directives at the population level ((Kawachi and Berkman, 2000)). Therefore, communities with stronger social networks are more likely to be prepared for extreme climate impacts because of access to information and social support ((Buckland and Rahman, 1999)).

At the same time, it is important to note that social networks can also function to discourage effective adaptation to extreme events. External support, such as financial resources, may actually create inequalities amongst community members resulting in contention and weakened social networks ((Ford *et al.*, 2006)). The utilization of social networks can also be prevented by the status of particular social groups, such as illegal and legal settlers or immigrants ((Wisner *et al.*, 2004)). Other social and environmental contextual factors must be considered when conceptualizing the role of social networks in managing extreme events. For example, strong social networks have facilitated adaptability in Inuit communities, but are being undermined by the dissolution of traditional ways of life ((Ford *et al.*, 2006)).

5.3.5.5. Integrating Local Knowledge

Local and traditional knowledge is increasingly valued as important information to include when preparing for disasters ((McAdoo *et al.*, 2009; Shaw *et al.*, 2009)). It is embedded in local culture and social interactions and transmitted orally over generations ((Berkes, 2008)). Place-based memory of vulnerable areas, know-how for responding to recurrent extreme events, and detection of abnormal environmental conditions manifest the power of local knowledge. Because local knowledge is often tacit and invisible to outsiders, it is used to reveal and enhance community participation in disaster management ((Battista and Baas, 2004)). Turner *et al.* ((Turner and Clifton, 2009)) state that participation of indigenous peoples provides local knowledge, and other alternative adaptation approaches. Local knowledge is also an important anchor for communities in relating to external knowledge such as scientific knowledge and national policies. In many places where local knowledge is used, communities set up trusted intermediaries to transfer and communicate external knowledge such as a technology-based early warning system and incorporate into the local knowledge system ((Bamdad, 2005; Kristjanson *et al.*, 2009)).

Within a climate change context, indigenous people, who are long-term residents who have often conserved their resources *in situ*, provide important information about changing environmental conditions ((Salick and Ross, 2009)(Turner and Clifton, 2009)) as well as actively adapting to the changes ((Macchi *et al.*, 2008; Salick and Byg, 2007)). Research is emerging in helping to document changes that indigenous people (people living with local and traditional cultures)((Salick and Ross, 2009)) are experiencing ((Ensor and Berger, 2009)(Ensor and Berger, 2009)). Although this evidence might be similar to scientific observations from external researchers, the fact that local communities are observing it is initiating discussions existing and potential adaptation to these changes from within the community ((Byg and Salick, 2009)). In six villages in eastern Tibet, near Mt. Khawa Karpo, documentation of changes experienced by local indigenous groups were consistent across areas, such as warmer temperatures, less snow, and glacial retreat, whereas other observations were more varied, including those for river levels and landslide incidences ((Byg and Salick, 2009)). In Gitga'at (Coast Tsimshian) Nation of Hartley Bay, British Columbia, indigenous people are noticing the decline of some species but also new appearances of others, anomalies in weather patterns and declining health of forests and grasslands that have affected their ability to harvest food ((Turner and Clifton, 2009)).

One of the challenges of biodiversity changes related to the climate is that many indigenous people depend on the variety of wild plants, crops and their environments particularly in times of disaster ((Turner and Clifton, 2009)). Changes in biodiversity are threatening historical coping strategies. There are numerous other challenges that indigenous people have to face in coping with climate change. In dryland areas such as in Namibia and Botswana one of the indigenous strategies best adapted to frequent droughts is livestock herding, including nomadic pastoralism ((Ericksen *et al.*, 2008)). Decreased access to water sources through fencing and privitization has inhibited this robust strategy. Also in Botswana, it has been suggested that government policies have weakened traditional institutions and practices, as they have not adequately engaged with local community institutions and therefore the mechanisms for redistributing resources have not been strengthened sufficiently ((Dube and Sekhwela, 2008)).

5.3.5.6. Local Government and Non-Government Initiatives and Practices

Governance structures are pivotal as they help shape efficiency, effectiveness, equity, and legitimacy of responses ((Adger *et al.*, 2003)). Current climate change management practices have tended to be centralized at the national level. This may be, in part, due to the ways in which many climate extremes affect environmental systems that cross political boundaries resulting in discordance if solely locally managed ((Cash and Moser, 2000)). Actions generated within and managed by communities, however, can be most effective since they are context-specific and tailored to local environments. If multiple levels of planning are to be implemented, mechanisms for facilitation and guidance on the local level are needed in order that procedural justice is guaranteed during the implementation of national policies at the local scale ((Thomas and Twyman, 2005)). In this light, local governments play an important role as they are responsible for providing infrastructure, preparing and responding to disasters, developing and enforcing planning, and connecting national government programs with local communities ((Huq *et al.*, 2007; UNISDR, 2009)). The quality and provision of these services have an impact on disaster and climate risk ((Tanner *et al.*, 2009)). Effective localized planning, for example, can minimize both the causes and consequences of climate change ((Bulkeley, 2006)). (Tanner *et al.*, 2009)

Though local government–led climate adaptation policies and initiatives are less pronounced than climate change mitigation measures, a growing number of cities are developing adaptation plans, though few have implemented their strategies ((Heinrichs, 2009); (Birkmann *et al.*, in press; Birkmann *et al.*, in press)). The Greater London Authority ((Greater London Authority, 2010)), for example, has prepared a Public Consultation Draft of their climate change adaptation strategy for London. The focus of this is on the changing risk of flood, drought and heat waves through the century and actions for managing them. Some of the actions include improvement in managing surface water flood risk, an urban greening program to buffer the impacts from floods and hot weather, and retro-fitting homes to improve the water and energy efficiency.

An assessment of the current state of progress on adaptation in eight cities (Bogotá, Cape Town, Delhi, Perl River Delta, Pune, Santiago, Sao Paulo and Singapore) suggests that adaptation tend to support existing disaster management strategies ((Heinrichs, 2009)). Another study comparing adaptation plans in nine cities including Boston, Cape Town, Halifax, Ho Chi Minh City, London, New York, Rotterdam, Singapore, and Toronto suggests that these cities' adaptation plans focus mostly on risk reduction and the protection of citizens and infrastructure, with Rotterdam seeing adaptation as opportunity for transformation ((Birkmann *et al.*, in press)). Most of these strategies have been led by Mayor's offices or environment departments. These nine cities have focused more on expected biophysical impacts than on socio-economic impacts and have not had a strong focus on vulnerability and the associated susceptibility or coping capacity. Although they aim to be integrated, they tend to have sectoral responses. Unfortunately with many of these cases, there is a good understanding of the impacts associated but the implementation of policy and outcomes on the ground are harder to see ((Bulkeley, 2006); (Burch and Robinson, 2007)).

In these adaptation strategies, the size of the local government is important, and it varies depending on the population and location. Primate and large cities exert more independence, whereas smaller municipalities depend more on higher levels of the government units, and often form associations to pool their resources ((Lundqvist, 2008)). In the latter case, state mandated programs and state-generated grants are the main incentives to formulate mitigation policies ((Aall, C., K. Groven,G.Lindseth, 2007)) and can be applicable to adaptation policies. Lack of resources and capabilities lead to outsourcing of local adaptation plans, and can generate insensitive and unrefined local solutions and technological fixes ((Crabbé, 2006)). To address this problem, participatory approaches are used to generate integrated assessments at the local level of vulnerabilities and formulate adaptation action plans.

The history and process of decentralization are also significant in the capacity of the local government to formulate and implement adaptation policies. Aligning local climate adaptation policies with the state/provincial and national/federal units is a significant challenge for local governments ((Van Aalst *et al.*, 2008)). Instead of the scaling up from localized assessments to national-level plans, communities often adopt mainstream climate change into the existing national and local policies ((Roberts, 2008)).

Although government actors play a key role, it is evident that non-government actors are crucial as well. While international agencies and NGOs play a norm-setting agenda at provincial, state, and national levels, community-based organizations (CBOs) often have greater capacity to mobilize at the local scale ((Milbert, 2006)). NGO and CBO networks play a critical role in capturing the realities of local livelihoods, facilitating sharing information, and identifying the role of local institutions that lead to strengthened local capacity ((Bull-Kamanga *et al.*, 2003)). Strong city-wide initiatives are often based on strategic alliances and local community organizations are essential to operationalizing city planning ((Hasan, 2007)(Hasan, 2007)).

Many non-government actors charged with managing climate risks use community risk assessment tools to engage communities in risk reduction efforts and influence planning at local and sub-national levels ((van Aalst, 2006)). NGO engagement in risk management activities ranges from demonstration projects, training and awareness-raising, legal assistance, alliance building, small-scale infrastructure, socio-economic projects, and mainstreaming and advocacy work ((Luna, 2001) (Shaw, 2006)). Bridging citizen-government gaps is a recognised role of civil society organisations and NGOs often act as social catalysts or social capital, an essential for risk management in cities ((Wisner, 2003)). Conversely, the potential benefits of social capital are not always maximised due to mistrust, poor communications or dysfunctionalities either within municipalities or non-government agencies. This has major implications for risk reduction ((Wisner, 2003)) and participation of the most vulnerable in non-government initiatives at municipal or sub-national level is not guaranteed ((Tanner *et al.*, 2009)).

5.4. Challenges and Opportunities

There are two key principles in disaster risk reduction that are applicable to climate change adaptation: 1) mainstreaming disaster prevention and mitigation into normal policies addressing social welfare, quality of life, infrastructure, and livelihoods; and 2) incorporating an all-hazards approach into planning and action. Disaster reduction is not only about reducing risks and exposure, but also includes systematic efforts to analyze and manage the causal factors of disasters by lessening societal vulnerability, improving land and environmental stewardship, improving preparedness, and enhancing societal resilience ((Bohle and Warner, 2008; Wisner, 2003)). Each presents challenges and opportunities for adaptation to climate extremes.

5.4.1. Differences in Coping and Risk Management

There are significant differences among communities and population groups in the ability to prepare for, respond to, recover from and adapt to disasters and climate extremes. For nearly sixty years, social science researchers have examined those factors that influence coping responses by households and communities through post-disaster field investigations as well as pre-disaster assessments ((Mileti, 1999; NRC (National Research Council), 2006)). Among the most significant individual characteristics are gender, age, wealth, ethnicity, livelihoods, entitlements, and health in the context of urban/rural divide. However, it is not only these characteristics operating individually, but also their synergistic effects that give rise to variability in coping and managing risks.

5.4.1.1. Gender

The literature suggests that at the local level gender makes a difference in vulnerability (Chapter 2), but it is also important in coping and risk management. In disasters, women tend to have different coping strategies and constraints on actions than men ((Peacock *et al.*, 2000)(Morrow and Enarson, 1996)(Fothergill, 1996)). These are due to the social position (class), marital status, education, wealth, and their caregiver roles. At the local level for example, women's lack of mobility and social isolation found in many places across the globe tend to augment risk, exposure, and vulnerability ((League of Red Cross and Red Crescent Societies, 1991; League of Red Cross and Red Crescent Societies, 1991; Mutton and Haque, 2004; Mutton and Haque, 2004; Schroeder, 1987)). Relief and recovery operations are often insensitive to gender issues, and so the provision of such supplies and services also influences the differential capacities to cope ((Enarson, 2000)(Fulu, 2007); (Ariyabandu, 2006; Wachtendorf *et al.*, 2006)).

5.4.1.2. Age

Age acts as an important factor in coping with disaster risk ((Cherry, 2009)). In North America, for example, retired people often choose to live in hazardous locations such as Florida or Baja California because of warmer weather and lifestyles, which in turn increases their potential exposure to climate-sensitive hazards. At the same time, older people are more prone to ill health, isolation, disabilities, and immobility ((Dershem and Gzirishvili, 1999; Ngo, 2001)), which negatively influence their coping capacities in response to extreme events (see Heat Case Study in Chapter 9). Often because of lack of declining hearing, mental capabilities, or mobility, older persons are less likely to receive warning messages, take protective actions, and are more reluctant to evacuate ((Hewitt, 1997; O'Brien and Mileti, 1992)). However, older people have more experience and wisdom with accumulated know-how on specific disasters/extreme events as well as the enhanced ability to transfer their coping strategies arising from life experiences.

At the other end of the age spectrum are children ((Peek, 2008)). Research has shown significant diminishment of coping skills (and increases in post-traumatic stress disorder and other psychosocial effects) among younger children following Hurricane Katrina ((Weems and Overstreet, 2008) (Barrett *et al*., 2008). In addition to physical impacts and safety ((Lauten and Lietz, 2008; Weissbecker, I., Sephton, S.E. *et al*., 2008)(Lauten and Lietz, 2008; Weissbecker, I., Sephton, S.E. *et al*., 2008)), research also suggests that emotional distress caused by fear of separation from the family, and increased workloads following disasters affects coping responses of children ((Babugura, 2008; Ensor, 2008)). However, the research also suggests that children are quite resilient and can adapt to environmental changes thereby enhancing the adaptive capacity of households and communities ((Pfefferbaum *et al*., 2008; Williams *et al*., 2008) (Bartlett, 2008; Manyena *et al*., 2008; Mitchell *et al*., 2008; Ronan *et al*., 2008)).

5.4.1.3. Wealth

The level of wealth at the local level affects the ability of a person/community to prepare for, respond to, and rebound from disaster events ((Masozera *et al*., 2007)). Wealthier communities have a greater potential for large monetary losses, but at the same time, they have the resources (insurance, income, political cache) to cope with the impacts and recover from extreme events. In Asia, for example, wealth shifted construction practices from wood to masonry which made many of the cities more vulnerable and less able to cope with disaster risk ((Bankoff, 2007)). Poorer communities and populations often live in cheaper hazard-prone locations, and face challenges not only in responding to the event, but also recovering from it. Poverty also enhances disaster risk ((Carter *et al*., 2007)). In some instances, it is neither the poor nor the rich that face recovery challenges, but rather communities that are in-between such as those not wealthy enough to cope with the disaster risk on their own, but not poor enough to receive full federal or international assistance. The recovery of New Orleans after Hurricane Katrina provides one example ((Finch *et al*., 2010)).

5.4.1.4. Intersectionality of Gender, Class, Age, and Ethnicity

The key characteristics that seem to influence social vulnerability were noted in Chapter 2 and elsewhere (Cutter *et al*., 2003). However, the individual characteristics of a person/family/community do not, indeed cannot, determine vulnerability to hazard events alone or how the family or community will cope with disaster risk. Rather, it is the interaction between all of these factors across space and through time results in a complicated system of stratification of wealth, power and status ((Heinz Center, 2002)). One of the best examples of this is the human experience with Hurricane Katrina (see Box 5-7): the intersection of race, class, age, and gender influenced differential decision making and perception of hazards; an uneven distribution of vulnerability and exposure resulting in disproportionate disaster losses; diverse types of hazard preparedness and disaster mitigation; and variable access to post-event aid, recovery and reconstruction(Elliott and Pais, 2006; Elliott and Pais, 2006; Hartman and Squires, 2006; Tierney, 2006)).

_____ START BOX 5-7 HERE _____

Box 5-7. Case Study – Hurricane Katrina Recovery and Reconstruction

Evacuation can protect people from injury and death, but extended evacuations (or temporary displacements lasting weeks to months) can have negative effects. Prolonged periods of evacuation can result in a number of physical and mental health problems ({{(Curtis *et al*., 2007; Mills *et al*., 2007)). Furthermore, separation from family and community members and not knowing when a return home will be possible also adds to stress among evacuees ((Curtis *et al*., 2007)Curtis et al., 2007). DeSalvo *et al*. ((DeSalvo *et al*., 2007)) found that long periods of displacement were among the key causes of post traumatic stress disorder in a study of New Orleans workers. These temporary displacements can also lead to permanent outmigration by specific social groups as shown by the depopulation of New Orleans five years after Hurricane Katrina ((Myers *et al*., 2008)).

_____ END BOX 5-7 HERE _____

5.4.1.5. Livelihoods

Livelihood is the generic term for all the capabilities, assets, and activities required for a means of living. Livelihood influences how families and communities cope with and recover from stresses and shocks ((Carney, 1998)). For poor communities living on fragile and degraded lands deteriorating environmental conditions undermine their livelihoods and capacity to cope with disasters. For example in areas where extreme climates are expected to increase in duration and frequency, certain community-based development activities, in particular, those that are characterized as sustainable livelihoods (SL) activities serve to build adaptive capacity and resilience to shocks ((Osman-Elasha, 2006b)).

Protecting and enhancing the natural services that buffer communities from climate impacts and provide them with a range of assets for coping with shocks will not only address immediate development priorities, but could improve local capacities to adapt to climate change ((Osman-Elasha, 2008; Spanger-Siegfried *et al*., 2005)). Sustainable strategies for disaster reduction help improve livelihoods (UNISDR, 2004)); while social capital, such as community networks support adaptation and disaster risk reduction by reducing the need for emergency relief in times of drought and/or crop failure ((Devereux and Coll-Black, 2007)) (see 5.2.5). A research study in South Asia suggests that adaptive capacity and livelihood resilience depend on social capital at the household level (i.e. education and other factors that enable individuals to function within a wider economy), the presence or absence of local enabling institutions (local cooperatives, banks, self-help groups), and the larger physical and social infrastructure that enables goods, information, services and people to flow. Interventions to catalyze effective adaptation are important at all these multiple levels ((Moench and and Dixit, 2004)).

5.4.1.6. Entitlements

Extreme climate events generally lead to entitlement decline in terms of the rights and opportunities that local people have to access and command the livelihood resources that enable them to deal with and adapt to climate stress. Entitlement decline can affect environmental entitlements ((Leach *et al*., 1999)), food entitlements ((Sen, 1981)) and, more generally, all the material, social, political and cultural resources that are the basic building blocks of any coping and adaptation options towards disaster risk and climate stress.

The buffering capacities of local people's livelihoods and their institutions are critical for their adaptation to extreme climate stress. More specifically, adaptive capacities rest on the ability of communities to generate potentials for self-organization, for social learning and innovations ((Adger *et al*., 2006)), with a focus on social actors, their practices and their agency that allow for resilient transformations ((Bohle, H.-G., B. Etzold,M.Keck, 2009)). Community institutions regulate the access to adaptation resources. Institutions, as purveyors of the rules of the game ((North, 1990)), mediate the socially differential command over livelihood assets, thus determining protection or loss of entitlements. These rules are constantly made and remade through local people's social practices, but they are also contested and struggled over ((Bohle, H.-G., B. Etzold,M.Keck, 2009)). Entitlement protection thus requires adaptive types of institutions and patterns of behaviour ((Bohle, H.-G., B. Etzold,M.Keck, 2009)), with a focus on local people's agency within specific configurations of power relations. The challenge is therefore, to empower the most vulnerable to pursue livelihood options that strengthen their entitlements and protect what they themselves consider the social sources of adaptation and resilience in the face of extreme climate stress.

5.4.1.7. Health and Disability

Climate change contributes to 160,000 annual deaths globally due to vector borne diseases, food insecurity, heat waves and other problems ((Campbell-Lendrum *et al*., 2003)). The extreme impacts of climate change (Chapters 3 and 4) are likely to directly or indirectly affect the health of many populations. Mortality rates may increase, and morbidity of a diversity of illnesses can increase. Extreme temperature rise leads to heatstroke, while cardiopulmonary problems and respiratory illness are linked to shifts in air pollution concentrations such as ozone ((Bernard *et al*., 2001)). Extreme heat events differentially affect populations based on their race, gender, age ((Díaz *et al*., 2002)), and medical and socioeconomic status (McGeehin and Mirabelli 2001), consequently raising concerns about health inequalities (see Chapter 9 case study). Vector-borne illnesses are projected to increase in geographic reach and severity as temperatures increase ((McMichael *et al*., 2006)). As seasons lengthen, mosquitoes and other vectors begin to inhabit areas previously free from such vectors of transmission. A range of vector-borne illnesses has been linked to climate, including malaria, dengue, Hantavirus, Bluetongue, Ross River Virus, and cholera (Patz et al. 1996).

The disaster literature generally discusses public health and disability as important in the response (post event) phase of the event cycle ((Shoaf and Rottmann, 2000)). Literature in the public health field also suggests that pre-existing health conditions can exacerbate the impact of disaster events since these populations are more susceptible to additional injuries from disaster impacts ((Brauer, 1999); (Brown, 1999; Parati *et al*., 2001)). Pre-event health conditions/disabilities can also lead to subsequent communicable diseases and illnesses in the short term, to lasting chronic illnesses, and to longer term mental health conditions ((Shoaf and Rottmann, 2000)(Bourque *et al*., 2006; Few and Matthies, 2006)).

There are few consistent databases for monitoring mortality from natural hazards ((Borden and Cutter, 2008; Thacker *et al*., 2008)). However, two recent all-hazards studies for the U.S. found from 1970-2004, climate-sensitive hazards (severe weather in the summer and winter, and heat) accounted for the majority of recorded fatalities from natural hazards. Geographically, fatalities were greatest in the coastal counties bordering the Gulf of Mexico and South Atlantic (the U.S. hurricane coast), in rural counties, and in the American South ((Borden and Cutter, 2008)).

5.4.1.8. Urban/Rural

Settlement patterns are another factor that influences disaster risk management and coping with extremes. In many countries, rural livelihoods and poverty are the drivers of disaster risk and this will intensify under climate extremes. Poverty, resource scarcity, and access to resources constrains disaster risk management and when coupled with climate variability, conflict, and health issues further compounds the coping capacity of rural places ((UNISDR, 2009)). At the other extreme are the concentrated settlements of cities where the disaster risks are magnified because of population densities, poor living conditions including overcrowded and substandard housing, lack of sanitation and clean water, and health impairments from pollution among others issues ((Bull-Kamanga *et al*., 2003; De Sherbinin *et al*., 2007)). Strengthening local capacity in terms of housing, infrastructure, and disaster preparedness is one mechanism shown to improve urban resilience, and the adaptive capacity of cities to climate-sensitive hazards ((Pelling, 2003)).

Given the rapid rate of growth in the largest of the world's cities, called megacities and mega-regions, the disaster risks will increase in the next decade placing more people in harm's way with untold billions of dollars in infrastructure located in highly exposed areas ((Wenzel *et al*., 2007); (Kraas *et al*., 2005);(Munich Re Group, 2004)). The complex and dynamic interaction between social, economic, political, and environmental processes insures that when a disaster strikes one of these megacities or mega-regions, there will be catastrophic losses of lives, property, and economic wealth resulting in major humanitarian crises ((Mitchell, 1999)).

For many regions, the ability to limit exposure has already been achieved through building codes, land management, and structural mitigation, yet losses keep increasing. For disaster reduction to become more effective, megacities will need to address their societal vulnerability and the driving forces that produce it (rural to urban migration, livelihood pattern changes, wealth inequities). Many megacities have reached their tipping points, and are seriously compromised in their ability to prepare for and respond to present disasters, let alone adapt to future ones influenced by climate change ((Heinrichs, 2009; World Bank, 2009);(Fuchs, 2009)).

5.4.2. Costs of Managing Disaster Risk and Risk from Climate Extremes

Large-scale disasters can cause considerable economic damage, on the order of magnitude of one percentage point of total wealth or several percentage points of GDP, which could threaten economic growth ((ADB, 2003); (Stern, 2007; Stern, 2007)(Cummins and Mahul, 2008)). Studies demonstrated that disaster prevention and mitigation can pay high dividends. For example Mechler (Mechler, 2005) found that for every Euro invested broadly in risk management, 2 to 4 Euros were returned in terms of avoided or reduced disaster impacts on life, property, the economy and the environment). In the United States, the Multihazard Mitigation Council found that for every dollar invested in pre-impact mitigation activities, four dollars were saved in potential losses ((Multihazard Mitigation Council, 2005)). There is a growing recognition of the potential role of social protection as a response to the multiple risks and stressors associated with disaster management and climate extremes, however little is known about local practices and cost-savings.

5.4.2.1. Costs of Impacts, Costs of Post-Event Responses

It is extremely difficult to assess the total cost of a large scale event, such as Hurricane Katrina, especially at the local scale. Direct and indirect losses are two ways to account for the costs of impact (see Chapter 4). Direct losses can be separated into direct market losses and direct non-market losses (intangible losses). They include health impacts, loss of lives, natural asset damages and ecosystem losses, and damages to historical and cultural assets. Indirect losses [also labelled higher-order losses ((Rose, 2004) or hidden costs ((Heinz Center, 1999))] include all losses that are not provoked by the disaster itself, but by its consequences. Measuring indirect losses is important as it evaluates the overall economic impact of the disaster on society. The assessment of indirect losses is difficult at the local scale because of the limited availability of economic data at this level. In addition, the relationship between the affected area and the world beyond can complicate the assessment. For example, local losses can be compensated from various inflows of goods, workers, and capital from outside the area to assist with reconstruction, along with governmental or foreign aid ((Eisensee and Stromberg, 2007)). At the same time, local disasters can provide ripple effects and influence world markets, such as Hurricane Katrina's impact on the world oil market, when most of the Gulf of Mexico oil rigs were shut down for weeks. Trade-offs in business loss and gain at different spatial scales need to be considered in accounting for indirect losses at the local level.

Despite the difficulties noted above, many local studies exist. For example, Strobl ((Strobl, 2008)) provided an econometric analysis of the impact of the hurricane landfall on county-level economic growth in the U.S. This analysis showed that a county struck by at least one hurricane over a year saw its economic growth reduced on average by 0.79%, and increased by 0.22% the following year. The economic impacts of the 1993 Mississippi flooding in the U.S. showed significant spatial variability within the affected regions. In particular, states with a strong dependence on the agricultural sector had a disproportionate loss of wealth compared to states that had a more diversified economy ((Hewings and Mahidhara, 1996; Hewings and Mahidhara, 1996)}}). Noy and Vu ((Noy and Vu, 2009)) investigated the impact of disasters on economic growth in Vietnam at the provincial level, and found that fatal disasters decreased economic production while costly disasters increased short-term growth. Studies also found that regional indirect losses increase nonlinearly with direct losses ((Hallegatte, 2008)), and can be compensated by importing reconstruction means (workers, equipment, finance) from outside the affected regions.

5.4.2.2. Adaptation and Risk Management-Present and Future

Adaptation cost estimates are based on various assumptions about the baseline scenario and the optimality of adaptation measures. The difference between these assumptions makes it impossible to compare or aggregate results. Yohe *et al*. ((Yohe, G., J. Neumann, P. Marshall,H.Ameden, 1996; Yohe, G., J. Neumann,H.Ameden, 1995; Yohe *et al*., 2011)) and West *et al*. ((West, J., Small, MJ, and Dowlatabadi, H., 2001)), for example, assess the economic cost of the sea-level rise in the United States for two baselines. The first baseline (perfect foresight) presumed that efficient coastal real estate markets would internalize impending inundation from rising seas and depreciate the economic value of any structure that would not be protected to zero, just as the waters arrived. The second baseline (no-foresight) assumes that property owners would maintain their properties as long as possible (for various reasons including imperfect anticipation and moral hazard linked to likely public support). Estimates of the economic cost of rising seas including the cost of adaptation were significantly higher in the no-foresight baseline.

In another study involving the water sector, Venkatesh and Hobbs ((Venkatesh, 1999)) investigated the role of uncertainty on future climate change in investment decision-making, and demonstrated the value of deferring decision to wait for additional information to avoid the consequences of inadequate adaptation. In the agriculture sector, estimates have been done using various assumptions on adaptation behavior ((Schneider, S.H., K. Kuntz-Duriseti,C.Azar, 2000)), from the farmers who do not react to observed changes in climate conditions (especially in studies that use crop yield sensibility to weather variability((Deschenes, 2007; Lobell, D.B., M. B. Burke, C. Tebaldi, M. D. Mastrandrea, W. P. Falcon,R.L.Naylor, 2008; Schlenker, 2010)) to the introduction of selected adaptation measures within crop yield models ((IFRI, 2009; Rosenzweig, 1994)) to the assumption of perfect adaptation with Ricardian approaches ((Kurukulasuriya, 2008a; Kurukulasuriya, 2008b; Mendelsohn, 1999; Seo, 2008)). Realistic assessments fall between these extremes, and a realistic representation of future adaptation pattern depend on the in-due-time detection of the climate change signal ((Hallegatte, 2009; Schneider, S.H., K. Kuntz-Duriseti,C.Azar, 2000)); the inertia in adoption of new technologies ((Reilly, 2000)); the existence of price signals ((Fankhauser *et al*., 1999)); and non-rational behavior.

Adaptation choices to climate extremes at the city scale often employed simplified catastrophe risk assessments. Jacob *et al*. ((Jacob, K., V. Gornitz, C. Rosenzweig, L. McFadden, R. Nicholls,E.Penning-Rowsell (eds.), 2007)) investigated the vulnerability of the New York City metropolitan area to coastal hazards and sea level rise and found that without any adaptation a 1-meter sea level rise would increase mean annual losses due to storm surges by a factor of three. A different study of New York City by Rosenzweig and Solecki ((Rosenzweig, 2001)) used historical analogues to derive annualised losses for different storm frequencies. They calculated projected damages of approximately 0.1% of Gross Regional Product, annualised, and a probable maximum loss of 10-25% of GRP for one event. Hallegatte *et al*. ((Hallegatte, S., N. Ranger, O. Mestre, P. Dumas, J. Corfee-Morlot, C. Herweijer,R.Muir Wood, 2010)) and Ranger *et al*. ((Ranger, N., S. Hallegatte, S. Bhattacharya, M. Bachu, S. Priya, K. Dhore, F. Rafique, P. Mathur, N. Naville, F. Henriet, C. Herweijer, S. Pohit,J.Corfee-Morlot, 2010)) coupled direct economic impact analyses with an economic input-output (IO) model to assess losses for Copenhagen and Mumbai, respectively. The output is an assessment of the direct and indirect economic impacts of storm surge under climate change including production, job losses, reconstruction time, and the benefits of investment in upgraded coastal defences. In Copenhagen, mean annual losses are currently negligible, but would soar even with only a limited rise in sea level in the absence of upgraded protection; protection that is relatively inexpensive in financial terms. Ranger *et al*. ((Ranger, N., S. Hallegatte, S. Bhattacharya, M. Bachu, S. Priya, K. Dhore, F. Rafique, P. Mathur, N. Naville, F. Henriet, C. Herweijer, S. Pohit,J.Corfee-Morlot, 2010)) found that losses from the 1-in-100 year rainfall flood in Mumbai could be multiplied by a factor of 3 under a pessimistic climate change scenario. However adaptation could significantly reduce those future losses by as much as 70%.

Studies on the costs of local disaster risk management are scarce, fragmented, and conducted mostly in rural areas. One study estimated the cost/benefit ratio of disaster management and preparedness programs in villages of Bihar and Andra Pradesh, India to be 3.76 and 13.38, respectively ((Venton and Venton, 2004)). Research undertaken by the Institute for Social and Environmental Transition (ISET) on a number of cases in India, Nepal and Pakistan also consistently demonstrated positive benefit to cost ratios and notes that return rates are particularly robust for lower-cost, local level interventions (including such actions as raising house plinths and fodder storage units, community based early warning, establishing community grain or seed banks, and local maintenance of key drainage points) when compared to embankment infrastructure strategies that require capital investment ((Moench, M.,and the Risk to Resilience Study Team, 2008)). The studies demonstrated a sharp difference in the effectiveness of the two approaches, concluding that the embankments historically have not had an economically satisfactory performance. In contrast, the benefit/cost ratio for the local level strategies indicated economic efficiency over time and for all climate change scenarios ((Dixit, A., Pokhrel, A, and Marcus Moench, M, 2008)).

5.4.2.3. Consistency and Reliability of Cost and Loss Estimations at Local Level

There are inconsistencies in present disaster risk loss data at all levels—local, national, global—which ultimately influences the accuracy of such estimates (Downton and Pielke Jr., 2005; Guha-Sapir and Below, 2002; Pielke Jr. *et al*., 2008). The reliability of disaster economic loss estimates is especially problematic at the local level due to: 1) the spatial coverage and resolution of databases that are global in coverage, but only at the national level with no consistent sub-national data; 2) thresholds for inclusion where only large economically-significant disasters are included, thus biasing the data toward singular events with large losses, rather than multiple, smaller events with fewer losses; and 3) what gets counted varies between databases (e.g. insured vs. uninsured losses; direct vs. indirect)((Gall *et al*., 2009)).

Similarly, there is a large uncertainty on impact and adaptation costs, again for multiple reasons. First, there is a large uncertainty in future emissions of greenhouse gases, which translates into a large uncertainty in the amplitude of future global climate change ((Solomon *et al*., 2007)). Second, there are uncertainties in the magnitude and pattern of local climate change, and of local climate variability and extremes (see Chapter 3). Third, the assessment of climate change impacts at the local scale is difficult, especially the lack of consensus on the discount rate ((Heal, 1997; Tol, 2003); (Nordhaus, 2007; Stern, 2007; Weitzman, 2007)) and on the evaluation of non-market costs, especially the value of biodiversity or cultural heritage ((Pearce, 1994)). Finally, the possibility of low-probability high-consequence climate change is not fully included in most analysis ((Lonsdale *et al*., 2008; Nicholls *et al*., 2008; Stern, 2007; Weitzman, 2009)).

5.4.3. Limits to Adaptation

If extreme events happen more frequently and/or with greater intensity/magnitude some locations may be uninhabitable for lengthy and repeated periods rendering sustainable development impossible. In such a situation, not all communities will be able to adapt without considerable disruption and costs (economic, social, cultural and psychological) and in some cases forced migration may be the only alternative ((Brown, 2008)). Changes in mean conditions may cause the effects of extreme events to be magnified. For example, sea level rise may cause storm surges to reach greater heights and move increased distances inland from the shore. On atolls, such changes may lead to complete inundation during storm events, occurrences which already occur during major tropical cyclones. Such inundation renders the ghyben-herzberg freshwater lens, critical for water supply and agriculture, saline and unusable for extended periods of time ((Anderson, 2002; Burns, 2003)). Water supplies on atolls may be increasingly tenuous if climate change causes increased incidence or duration of drought events ((Barnett and Adger, 2003)). These conditions may be exacerbated by coastal erosion ((World Bank, 2000)), with many atolls becoming increasingly uninhabitable. The only adaptation option may be the migration of whole communities and in the cases of countries comprising only atolls such relocation would need to be international in scale ((Campbell, 2010b)).

Densely populated regions in developing countries suffer the brunt of natural disasters ((UNISDR, 2004)). More than half of the global population now lives in urban areas with an increasing population exposed to multiple risk factors ((UNFPA, 2009)). Risk is increasing in urban agglomerations of different size due to unplanned urbanization and accelerated migration from rural areas or smaller cities ((UN-HABITAT, 2007)). The 2009 Global Assessment Report on Disaster Risk Reduction ((UNISDR, 2009)) lists unplanned urbanization and poor urban governance as two main underlying factors accelerating disaster risk. It highlighted that the increase in global urban growth of informal settlements in hazard prone areas reached 900 millions in informal settlements, increasing by 25 million per year. Urban hazards exacerbate disaster risk by the lack of investment in infrastructure as well as poor environmental management, thus limiting the adaptive capacity of these areas.

Local actions on adaptation face many types of constraints depending on the type of hazard and degree of exposure as well as the availability and accessibility to information and knowledge. For example, communities living in areas prone to climate extremes such as frequent drought have developed certain coping/survival responses that assisted them to survive harsh conditions. Over time, these coping responses proved inadequate due to the magnitude of the problem ((Ziervogel *et al.*, 2006)). The information gap is particularly evident in many developing countries with limited capacity to collect, analyze and use demographic and mortality data on mortality and demographic trends, as well as evolving environmental conditions ((IDRC, 2002; National Research Council, 2007); (Carraro *et al.*, 2003)). Based on Fischer *et al.* ((Fischer *et al.*, 2001)) closing the information gap is critical to reduce climate change related threats to rural livelihoods and food security in Africa. Moreover, the lack of access to information by local people has reduced improvements in knowledge, understanding and skills, needed elements to help communities undertake improved measures to protect themselves against disasters and climate change impacts ((Agrawal *et al.*, 2008)). Improving community access to information and control over resources will have a great bearing on their capacity to prepare, mitigate, manage, and respond and recover from any future disaster.

Lack of capacities and skills, particularly by women also has been identified as a limiting factor for effective local adaptation actions ((Osman-Elasha *et al.*, 2006)). Reducing community's vulnerabilities particularly women's through capacity-building and instilling new skills and knowledge proved an effective approach for improving the local adaptive capacity. A successful initiative in Mali involves empowering women and giving them the skills to diversify their livelihoods, thus linking environmental management, disaster risk reduction, and the position of women as key resource managers (UN, 2008).

In developed countries, household decisions regarding disaster risk reduction, and by extension, adaptation, are often guided by factors other than cost. For example, Kunreuther and Michel-Kerjan ((Kunreuther *et al.*, 2009)) found that most individuals underestimate the risk and do not make cost-benefit trade-offs in their decisions to purchase hazard insurance and/or have adequate coverage. They also found empirical evidence to suggest that the hazard insurance purchase decision was driven not only by the need to protect assets, but also to reduce anxiety, satisfy mortgage requirements, and social norms (p. 120). For other types of mitigation activities, households do not voluntarily invest in cost-effective mitigation because of underestimating the risk, taking a short-term rather than long-term view, and not learning from previous experience (p. 247). However, they found social norms significant: if homeowners in the neighborhood installed hurricane shutters, most would follow suit; the same was true of purchasing insurance ((Kunreuther *et al.*, 2009)). For municipal governments, adoption of building codes in hurricane prone areas reduces damages by $10 a square foot for homes built between 1996-2004 in Florida ((Kunreuther *et al.*, 2009)). However, enforcement of building codes by municipalities is highly variable and becomes a limiting factor in disaster risk management and adaptation.

5.5. Management Strategies

There are a variety of strategies for managing disaster risk and adaptation to climate extremes at the local level. These range from baseline assessments of disaster risk to vulnerability assessments to social transfers. A few of the most utilized strategies by local actors and for local places are described.

5.5.1. Methods, Models, Assessment Tools

Prior to the development and implementation of management strategies and adaptation alternatives, local entities need baseline assessments on disaster risk and the likely impacts of climate extremes. The assessment of local disaster risk includes three distinct elements: 1) Exposure (risk) assessment, or the identification of hazards and their potential magnitudes/severities as they relate to specific local places; 2) Vulnerability assessments that identify the sensitivity of the population to such exposures and the capacity of the population to cope with and recover from them; and 3) Damage assessments that determine direct and indirect losses from particular events (either *ex -post* in real events or *ex-ante* through scenarios or modeling for hypothetical events). Each of these plays a part in understanding the hazard vulnerability of a particular locale or characterizing not only who is at risk but also the driving forces behind the differences in disaster vulnerabilities in local places.

There are numerous examples of exposure and vulnerability assessment methodologies and metrics ((Birkmann, 2006)). Of particular note are those studies focused on assessing the sub-national exposure to coastal hazards ((Gornitz *et al*., 1994; Hammer-Klose and Thieler, 2001)), drought ((Alcamo *et al*., 2008; Kallis, 2008; Wilhelmi and Wiilhite, 2002)), or multiple hazards such as FEMA's multi-hazard assessment for the United States ((FEMA, 1997)).

Vulnerability assessments highlight the interactive nature of disaster risk exposure and societal vulnerability. While many of them are qualitative assessments ((Birkmann, 2006) (Bankoff *et al*., 2004)), there is an emergent literature on quantitative metrics in the form of vulnerability indices. The most prevalent vulnerability indices, however, are national in scale ((Cardona, 2007; Cardona, 2007; Cardona, 2007; SOPAC and UNEP, 2005)) and compare countries to one another, not places at sub-national geographies. The exceptions are the empirically-based Social Vulnerability Index (or SoVI^{TM}) ((Cutter *et al*., 2003)) and extensions of it ((Fekete, 2009)).

Vulnerability assessments are normally hazard specific and many have focused on climate-sensitive threats such extreme storms in Revere, Massachusetts ((Clark *et al*., 1998), sea level rise in Cape May, New Jersey((Wu *et al*., 2002)) or flooding in Germany ((Fekete, 2009)) and the U.S. ((Burton and Cutter, 2008);(Zahran *et al*., 2008)). Research focused on multi-hazard impact assessments range from locally-based county level assessments for all hazards in Georgetown County, South Carolina ((Cutter *et al*., 2000)) to sub-national studies such as those involving all hazards for Barbados and St. Vincent ((Boruff and Cutter, 2007)) to those involving a smaller subset of climate-related threats ((Alcamo *et al*., 2008; O'Brien *et al*., 2004); (Brenkert and Malone, 2005)). The intersection of local exposure to climate-sensitive hazards and social vulnerability was recently assessed for the northeast ((Cox *et al*., 2007)) and southern region of the US ((Oxfam, 2009; Oxfam, 2009)).

However, the full integration of risk exposure and social vulnerability into a comprehensive vulnerability assessment for the local area or region of concern is often lacking for many places. Part of this is a function of the bifurcation of the science inputs (e.g. natural scientists provide most of the relevant data and models for exposure assessments while social scientists provide the inputs for the populations at risk) and the difficulties of working across disciplinary or knowledge boundaries.

5.5.2. Social, Financial, and Risk Transfers

5.5.2.1. Social Transfers

Social protection (SP) describes all public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalised ((Devereux and Sabates-Wheeler, 2004)). These initiatives have the overall objectives of extending the benefits of economic growth, and reducing the economic and social vulnerability of poor, vulnerable and marginalised groups. These can be divided into *core* SP interventions, such as asset transfers, income transfers and public works, or *complementary* interventions, such as micro-credit services, social development, skills training and market enterprise programmes.

SP has risen significantly up the international policy agenda in recent years, partly due to the impacts of the global financial crises in the late 1990 and early and late 2000s on poor and marginalised people ((Davies and McGregor, 2009)(G20, 2009)). It is now becoming increasingly recognised that SP can play an important role in the delivery of pro-poor climate change adaptation and disaster risk reduction (DRR) assistance to vulnerable populations in developing countries ((Heltberg *et al*., 2010)(Stern, 2007; Stern, 2007)). Table 5-4 provides a summary of the SP measures and instruments, and associated adaptation and DRR benefits ((Davies *et al*., 2009a)).

[INSERT TABLE 5-4 HERE:
Table 5-4: Social protection measures and instruments, and associated adaptation benefits.]

As Table 5-4 shows, SP offers a wide range of benefits for adaptation and DRR, both in response to short-term climate disasters, as well as long-term risks posed by climate change. The concept of Adaptive Social Protection (ASP) provides a framework for the integration of SP, climate change adaptation and DRR into one coherent approach ((Davies and Leavy, 2007)). However, in spite of these conceptual advancements, there are only a few studies on the implications of SP implementation for dealing better with climate events. Of the studies that do exist, most have been conducted in South Asia ((Arnall *et al*., 2009; Heltberg *et al*., 2009)), although a number have also been completed in relation to individual safety net programmes in sub-Saharan Africa ((Devereux *et al*., 2006)(Slater *et al*., 2006)). According to Heltberg ((Heltberg *et al*., 2009)), SP has formed an important part of the World Bank's disaster response in several major recent climate-related disasters in south Asia. Such support included direct cash to affected households, and workfare (cash-for-work). In Africa, preliminary lessons from Ethiopia's nation-wide Productive Safety Net Programme (PSNP), which assists the most chronically impoverished with cash transfers and cash-for-work schemes, reveal a positive effect on household food consumption ((Devereux *et al*., 2006)) and a reduction in 'distress selling' of assets as well as the protection of household assets ((Slater *et al*., 2006)). In these situations, proactive safety nets in the form of cash transfers and work programmes appear to present a viable alternative to traditional post-disaster relief responses. However, it is important to have such programmes in place before the onset of disasters, with flexible targeting, financing and implementation arrangements for scaling up as appropriate ((Alderman and Haque, 2006)), and prevention and risk management measures already integrated in ((Bockel *et al*., 2009)).

Other social protection instruments used occasionally in disasters in south Asia are conditional cash transfers, near-cash instruments such as vouchers and fee waivers, social funds, and specific services such as child protection, orphanages, and rehabilitation for persons with disabilities ((Heltberg *et al*., 2009)). In Bangladesh, recent experiences of asset restocking following disasters ((Marks, 2007)(Devereux and Coll-Black, 2007);(Tanner *et al*., 2007)) demonstrate that such approaches can contribute to reducing vulnerability to climate shocks by providing liquidity and alternative sources of income during times of household stress ((Davies *et al*., 2009b)). In addition, starter packs and seed fairs have revealed success in boosting food production at the national and household level ((Devereux and Coll-Black, 2007)). These have been more commonly used in Africa, although concern has been expressed that inputs sourced through commercial seed and fertiliser companies are sometimes inappropriate to local cropping patterns and agro-ecological conditions ((Davies *et al*., 2009b)). Microcredits are another social protection measure (Ray-Bennett, 2010).

5.5.2.2. Insurance

Two types of insurance – formal/traditional and micro – serve the local population to spread stochastic losses geographically and temporally, and can assure timely liquidity for the recovery and reconstruction process. Insurance is an effective disaster risk reduction tool especially when combined with other risk management measures. For example, in most industrialized countries, insurance is utilized in combination with early warning systems, risk information and disaster preparation, and disaster mitigation. Where insurance is applied without adequate risk reduction, it can be a disincentive for adaptation, as individuals rely on insurance entirely to manage their risks and are left totally exposed to impacts ((Rao and Hess, 2009)). Furthermore, insurance can provide the necessary financial security to take on productive but risky investments ((Höppe and Gurenko, 2006)). Examples include a pilot project in Malawi where microinsurance is bundled with loans that enable farmers to access agricultural inputs that increase their productivity ((Hess and Syroka, 2005)), and a project in Mongolia that protects herders' livestock from extreme winter weather ((Skees *et al*., 2008)).

Formal insurance is utilized extensively in the industrialized countries, where it covers around 40 percent of disaster losses ((Höppe and Gurenko, 2006)) to residents and businesses. In 2008, premiums as a percentage of GDP typically exceeded 5% in industrialized countries and up to as high as 15%. However, coverage is heterogeneous across countries and lines of business ((Vellinga, P., E. Mills, G. Berz, L. Bouwer, S. Huq, L.A. Kozak, J. Palutikof, B. Schanzenbacher,G.Soler, 2001)). This results from differential levels of exposure, regulatory and economic conditions and market characteristics, all of which affect local communities. In many industrialized countries, the public sector plays some role in insuring risks, either by taking a slice of the risk, for example providing a backstop or 'insurer of last resort' for the most extreme catastrophe risks, or by covering lines that are uninsurable at an affordable rate by the private market ((Vellinga, P., E. Mills, G. Berz, L. Bouwer, S. Huq, L.A. Kozak, J. Palutikof, B. Schanzenbacher,G.Soler, 2001)). The U.S., for example, has a federally-backed National Flood Insurance Program (NFIP) although it continues to run at a deficit.

Typically insurance coverage expands with economic growth. Penetration is currently growing rapidly in the emerging economies, where the rate of growth in insurance premiums (+15% per year between 1998 and 2008) has far outstripped that in the developed world ((Swiss Re, 2009)). In 2008, total premiums from emerging economies stood at just over $0.5 trillion USD. Swiss Re ((Swiss Re, 2008)) describes that in developing countries, insurance is most common among the commercial and industrial sectors and higher income groups. In the non-life industry, the bulk of premium volumes come from the motor sector, with property insurance a relatively low proportion (e.g. 20 percent in India). The penetration of agricultural insurance in developing countries is low despite its economic importance, with premiums accounting for only 0.01 percent of GDP. In 2008, global annual non-life premiums (which include property and casualty lines) stood at $1.8 trillion USD ((Swiss Re, 2009)). Insurance has a much lower penetration in developing countries; here it covers only around 3 percent of disaster losses ((Höppe and Gurenko, 2006)). This results from a lack of affordability and distribution channels, but also socio-cultural factors (e.g. many poorer societies utilize informal social safety nets). New types of insurance are being designed to service these lower income groups; for example, micro-insurance.

Microinsurance is a financial arrangement to protect low-income people against specific perils in exchange for regular premium payments ((Churchill, 2006; Churchill, 2007)). Several pilot projects have yielded promising outcomes, yet experience is too short to judge if microinsurance schemes are viable in the long haul for local places. Many of the ongoing microinsurance initiatives are index-based: a relatively new approach whereby the insurance contract is not against the loss itself, but against an event that causes loss, such as insufficient rainfall during critical stages of plant growth ((Turvey, 2001)). Weather index insurance is largely at a pilot stage, with several projects operating around the globe, including in Mongolia, Kenya, Malawi, Rwanda and Tanzania ((Hellmuth *et al.*, 2009)). In India, a weather insurance program grew from covering just 1,100 farmers in 2004 to insuring over 700,000 farmers by 2008. Index insurance for agriculture is more developed in India, where the Agricultural Insurance Company of India (AIC) has extended coverage against inadequate rainfall to 700,000 farmers.

Index-based contracts as an alternative to traditional crop insurance have the advantages of greatly limiting transaction costs (from reduced claims handling) and eliminating moral hazard (as there are no incentives to negligent behavior because claims are independent of the farmers' practices). A disadvantage is their potential of a mismatch between yield and payout, a critical issue given the current lack of density of meteorological stations in vulnerable regions – a challenge that remote sensing may help address ((Skees and Barnett, 2006)). Participants' understanding of how insurance operates, as well as their trust in the product and the stakeholders involved may also be a problem for scaling up index insurance pilots, although simulation games and other innovative communication approaches are yielding promising results ((Patt *et al.*, 2009)). Affordability can also be a problem: because disasters can affect whole communities or regions (co-variant risks), insurers must be prepared for meeting large claims all at once, with the cost of requisite backup capital potentially raising the premium far above the client's expected losses – or budget. While valuable in reducing the long-term effects on poverty and development, insurance instruments, particularly if left entirely to the market, are not appropriate in all contexts ((Linnerooth-Bayer, 2010)).

The insurance industry itself is vulnerable to climate change. Eighty-seven percent of insured losses events between 1985 and 1999 were weather-related ((Munich Re Group, 2000)). Research by the Association of British Insurers ((Association of British Insurers (ABI), 2005)) concluded that an increase of just 6 per cent in wind speeds could increase average annual insured property losses in the United States from hurricanes from US$5.5 billion to around US$9.5 billion. The continuing exit of private insurances is seen with the increasingly catastrophic local losses in the U.S. ((Lecomte and Gahagan, 1998)), UK ((Priest *et al.*, 2005)) and Germany ((Botzen and van den Bergh, 2008)(Thieken *et al.*, 2006)). Climate change could be particularly problematic in communities, which begin to see new types of risks for which they are unprepared. Vellinga *et al.* 2001 ((Vellinga, P., E. Mills, G. Berz, L. Bouwer, S. Huq, L.A. Kozak, J. Palutikof, B. Schanzenbacher,G.Soler, 2001)) overview a number of dimensions of insurer vulnerability that could be impacted by climate change, including: the probable maximum loss; and pressures from regulators responding to changing prices and coverage ((Kunreuther *et al*., 2009)).

One response to rising levels and volatility of risk has been to increase insurance and reinsurance capacity through new alternative risk transfer instruments, such as index-linked securities (including catastrophe bonds) ((Vellinga, P., E. Mills, G. Berz, L. Bouwer, S. Huq, L.A. Kozak, J. Palutikof, B. Schanzenbacher,G.Soler, 2001)). Kunreuther and Michel-Kerjan ((Kunreuther *et al*., 2009)) and others suggest that these tools could play an increasingly important role in a new era of elevated catastrophe risks. Another approach is to reduce risks through societal adaptation ((Herweijer, C., N. Ranger,R.E.T.Ward, 2009)). For example, Lloyds of London (2008) demonstrates that in exposed coastal regions communities increase in average annual losses and extreme losses due to sea level rise in 2030 could be offset through investing in property-level resilience to flooding or sea walls. Similarly, RMS ((RMS, 2009)) shows that wind-related losses in Florida could be significantly reduced through strengthening buildings. Given the clear benefits of adaptation for insurance, Ward et al. 2008 ((Ward, R.E.T., C. Herweijer, N. Patmore,R.Muir-Wood, 2008)) describes a number of ways in which insurers themselves can help to promote adaptation through risk communication and financial incentives.

5.5.2.3. Social and Environmental Outcomes

One of the key issues in examining outcomes of local strategies for disaster risk management and climate change adaptation is the principle of fairness and equity. There is a burgeoning research literature on the climate justice looking at the differential impacts of adaptation policies ((Adger *et al*., 2006); (Kasperson and Kasperson, 2001)) at local, national, and global scales. The primary considerations at the local level are the differential impacts of policies on communities, subpopulations, and regions from present management actions (or inactions) ((Thomas and Twyman, 2005)). There is also concern regarding the impact of present management (or inactions) in transferring the vulnerability of disaster risk from one local place to another (spatial inequity) or from one generation to another (intergenerational equity) ((Cooper and McKenna, 2008)).

5.5.3. Adaptation as a Process

Experience in planning and implementing adaptation reveals that adaptation is a socio-institutional process bringing together a set of inter-twined elements ((Downing and Dyszynski, In press; Tschakert and Dietrich, In press)). O'Brien *et al*. ((O'Brien *et al*., 2009)) focus on the process of adaptation and suggest an adaptation continuum (see Figure 5-4), where the first stage is to focus on the impacts. As local capacity increases, the progression from vulnerability to adaptation to development, to resilience ensues. Throughout the process, learning increases and institutions change and a paradigmatic transformation occurs—the community moves away from an impact-focus perspective to a resilience-centric one where there is an expectation of risk and where good governance and key partnerships are the norm.

[INSERT FIGURE 5-4 HERE:
Figure 5-4: Dimensions of the adaptation continuum (O'Brien *et al*., 2009).]

A key component of the adaptation process is the ability to learn ((Armitage *et al*., 2008; Lonsdale *et al*., 2008; Pahl-Wostl *et al*., 2007)). This focus on learning partly derives from the fields of social-ecological resilience and sustainability science ((Berkes, 2009; Kristjanson *et al*., 2009)). The extension of social, participatory, and organizational learning to climate change adaptation has emphasized the significance of identifiable climate change signals, informal networks, and boundary organizations to enhance the preparation of people and organizations to the changing climate ((Berkhout, F., J. Hertin,D.Gann, 2006; Pelling, M., C. High, J. Dearing,D.Smith, 2008)). Participatory learning is especially emphasized ((Berkhout, 2002; Shaw, A., S. Sheppard, S. Burch, D. Flanders, A. Wiek, J. Carmichael, J. Robinson,S.Cohen, 2009; Shaw, A., S. Sheppard, S. Burch, D. Flanders, A. Wiek, J. Carmichael, J. Robinson,S.Cohen, 2009)). Focusing on what can be learnt from managing current climate risk is a good starting point particularly for poor and marginalized communities ((Someshwar, 2008)). As scenarios combine quantitative indicators of climate, demographic, biophysical, and economic change as well as qualitative storylines of socio-cultural changes at the local level, the participation of local stakeholders is essential to generate values and understandings of climate extremes.

If adaptation is a process rather than an end-point it requires a focus on the institutions and policies that enable or hinder this process ((Inderberg and Eikeland, 2009)) and the acknowledgement that there are often competing stakeholder goals ((Ziervogel and Ericksen, 2010)). Fostering better adaptive capacity for disaster and climate risk will help to accelerate future adaptation ((Inderberg and Eikeland, 2009; Moser, 2009; Patt, 2009)). However, there are barriers. These include lack of coordination between actors, and the complexity of the policy field hampering innovative approaches ((Mukheibir and Ziervogel, 2007; Winsvold *et al.*, 2009)). Limited human capacity to implement policies can also hamper adaptation ((Ziervogel *et al.*, 2010)), although individuals' perceptions of risk and adaptive capacity can determine whether adaptation responses are initiated or not ((Grothmann and Patt, 2005)).

5.6. Information, Data, and Research Gaps at the Local Level

The causal processes by which disasters produce systemic effects in chronological and social time is reasonably well-known and has been outlined by Kreps and others ((Cutter, 1996; Kreps, 1985; Lindell and Prater, 2003)(NRC (National Research Council), 2006; NRC (National Research Council), 2006)). Yet, local emergency management communities have by and large paid little attention to the links between climate change and natural hazards ((Bullock *et al.*, 2009)). As a result, state and local mitigation plans, even when required by law, usually fail to include climate change, sea level rise, or extreme precipitation in hazard assessments or do so in entirely deterministic ways.

Decisions about development, hazard mitigation, and emergency preparedness in the context of climate change give rise to critical social and economic adaptation questions. For example
Do increased levels of hazard mitigation and disaster preparedness increase risk taking by individuals and social systems? Do cumulative impacts of smaller events over time compare to single high impact events? How do short-term adjustments or coping strategies enable or constrain long-term vulnerabilities? What are the tradeoffs among decision acceptability versus decision quality?

The hurricane recovery process includes ample evidence of how efforts to ensure that the rush to "return to normal" have also led to depletion of natural resources and increased risk. How decisions regarding the right to migrate (even temporarily), the right to organize and the right of access to information are made will, as a result, have major implications for the ability of different groups to adapt successfully to floods, droughts, storms and the other consequences anticipated as a result of climatic change. The idea of linking place-based recovery, preparedness, and resilience to adaptation is intuitively appealing. However, the constituency that supports improved disaster risk management has historically proven too small to bring about many of the changes that have been recommended by researchers, especially those that focus on strengthening the social fabric to decrease vulnerability. Behind the specific questions of the transparency of risk, are broader questions about the public sphere. What public goods will be provided by governments at all levels (and how will they be funded), what public goods will be provided by private or organizations in civil society, what will be provided by market actors, and what will not? How will these influence local-level disaster risk management, especially to climate-sensitive hazards?

While there has been increasing focus on the processes by which knowledge has been produced, less time has been spent examining the capacity of local communities to critically assess knowledge claims made by others for their reliability and relevance to those communities ((Pulwarty, 2007)Fischoff, 1996). There is the need to move beyond the integration of physical and societal impacts to focus on practice and evaluation. How are impediments to the flow information created? Is a focus on communication adequate to ensure effective response? How are these nodes defined among differentially vulnerable groups e.g. based on economic class, race, gender? However, there is little research on the extent to which local jurisdictions have adopted policy options and practice and the ways in which it is being implemented. Most of the studies to date have addressed factors that lead to policy adoption and not necessarily successful implementation.

Beyond infrastructure and retrofitting concerns, successful adaptation strategies integrate urban planning, water management, early warning systems and preparedness. One widely-acknowledged goal is to address, directly, the problem of an inadequate fit between what the research community knows about the physical and social dimensions of uncertain environmental hazards and what society chooses to do with that knowledge. An even larger challenge is to consider how different systems of knowledge about the physical environment, and competing systems of action can be brought together in pursuit of diverse goals that humans wish to pursue ((Mitchell, 2003)). Several sources (Comfort, et al 2009; (Bullock *et al*., 2009; McKinsey Group, 2009)(McKinsey Group, 2009)) have identified key requirements for addressing these challenges, including developing:

1) Multi-way information exchange systems-effective adaptation will always be locally-driven. Communities need reliable measurements and assessment tools, integrated information about risks that those tools reveal and best approaches to minimize those risks. The goal is to develop a coordinated effort to improve the assessment and transparency of risk in a geographic place-based approach to vulnerable regions. Better locally-based data on economic losses, disaster and adaptation costs, and human losses (fatalities) will ensure improved empirically-based baseline assessments.
2) Maps of the decision processes for disaster mitigation, preparedness, response and recovery and guidance for using such decision support tools. Hazard maps are the simplest and often most powerful form of risk information. They capture the likelihood and impact of a peril and are important for informing risk reduction and risk transfer. Such devices would identify: specific segments of threatened social systems that could suffer disproportionate disaster impacts; critical actors at each jurisdictional level; their risk assumptions; their different types of information needs; and the design of an information infrastructure that would support their decisions at critical entry points Comfort ((Comfort, 1993)).
3) People who face hazards should be assisted to manage their own environments more responsibly and equitably over the long term by joining in a global structure that supports informed, responsible, systematic actions to improve local conditions in vulnerable regions. Governments and institutions can support, provide incentives, and legitimize successful approaches to increasing capacity and action.
4) Methodologies and measurement of progress in reducing vulnerability and enhancing community capacity at the local is under researched. Locally-based risk management, cost-effectiveness methodologies and analyses, investigation of societal impacts of catastrophic events at local to national scales, and research on implementation of risk management and mitigation programs are all needed. Similarly, there is a critical need for the assessment and coordination of multi-jurisdictional and multi-sectoral efforts to help avoid the unintended consequences of actions.
5) Underserved people require to access to the social and economic security that comes from sharing risk, through financial risk transfer mechanisms such as insurance. There is a paucity of studies at the local level to assess the efficacy of alternative risk reduction or transfer methods, analysis of benefits and costs to various stakeholder groups, analysis of complementary roles of mitigation and insurance, and analysis of safeguards against insurance industry insolvency.

Previous studies have identified community hazard vulnerability, community resources, and especially, strategies and structures that emergency managers and other hazards professionals can adopt at low cost. The knowledge to construct regional geographic information systems that provide the information base for indices is already available ((Maskrey, 1989; National Academy of Public Administration (NAPA), 1998)(Maskrey, 1989; National Academy of Public Administration (NAPA), 1998)). Nonetheless, most studies have relied on limited samples and need further work to replicate and extend their findings. Interdisciplinary collaboration is clearly needed to prioritize and address research tasks for bridging knowledge gaps in our understanding. These gaps include: analyses of vulnerability that integrate into their assessment the extent to which knowledge is framed, co-produced and utilized; factors that promote the adoption of more effective community level hazard mitigation measures and assessments of the effectiveness of hazard mitigation programs; development and local calibration of better models to guide long-term protective action decision making in emergencies; understanding impacts, response and recovery for near-catastrophic and catastrophic disaster events at the local level; research and support for risk-pooling mechanisms for small-scale production units; and understanding the role and benefits of ecosystems services in providing buffers for uncertain risks.

The experiences of extreme events and sequences of events considered in this chapter validate the notion of socially constructed disasters. Risk reduction and hazard mitigation strategies must address the underlying practices that contribute to vulnerability. The goal is to be clearer about existing conditions and projected changes e.g. weakening of bridges, levees and other structures due to long exposure to water of changing quality and other corrosives. These actions will situate the scientific understanding of hazard within a broader discourse about different forms of knowledge, and increase the likelihood of public actions that are better grounded in scientific knowledge and customized for the local context.

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Table 5-1: Guidelines for grey literature inclusion.

1. Results and conclusions that are substantiated by evidentiary material presented in the document.
2. Objective and non-biased reports that lack obvious and explicit motives such as seeking further funding or promoting a particular cause.
3. Original reports customized for the specific local setting and situation and not repetitious reports done for different settings/locales by the same consultant/and or agency with formulaic presentations and findings.
4. The material was useful for triangulation of key findings.
5. Regional reports on disaster risk management and climate change adaptation when no other information was available and when they met the above criteria.

Table 5-2: Local experience with climate extreme hazards based on number of reported disasters, 1999-2008.

	Africa	Americas	Asia	Europe	Oceania	Total
Droughts	127	51	75	16	3	272
Temperature extremes	5	40	50	108	1	204
Floods	402	342	649	259	43	1,695
Wildfires	12	61	20	51	10	154
Mass movements (wet)	12	34	111	18	5	180
Windstorms (cyclones)	88	344	401	160	69	1,062
Regional Total	646	872	1,306	612	131	3,567

Source: International Federation of Red Cross and Red Crescent Societies, 2009. World Disasters Report 2009. http://www.ifrc.org/publicat/wdr2009/summaries.asp

Table 5-3: Top five climate extreme hazards events, 1950-2009.

	Country	Date	Event	Estimated Loss
Fatalities				
	1. China	July 1959	Flood	2 million
	2. India	1965	Drought	1.5 million
	3. Ethiopia	May 1983	Drought	300,000
	4. Bangladesh	Nov 1970	Storm	300,000
	5. Sudan	Apr 1983	Drought	150,000
People Affected				
	1. India	May 1987	Drought	300 million
	2. India	Jul 2002	Drought	300 million
	3. China	Jul 1998	Flood	239 million
	4. China	Jun 1991	Flood	210 million
	5. India	1972	Drought	200 million
Economic Damages				
	1. USA	Aug 2005	Hurricane Katrina	125 billion
	2. USA	Sep 2008	Hurricane Ike	30 billion
	3. China	Jul 1998	Flood	30 billion
	4. USA	Aug 1992	Hurricane Andrew	26.5 billion
	5. China	Jan 2008	Extreme temp	21.1 billion

Source: http://www.emdat.be/disaster-profiles

Table 5-4: Social protection measures and instruments, and associated adaptation benefits.

SP measure	SP instruments	Adaptation and DRR benefits
Provision (coping strategies)	– social service protection – basic social transfers (food/cash) – pension schemes – public works programmes	– protection of those most vulnerable to climate risks, with low levels of adaptive capacity
Preventive (coping strategies)	– social transfers – livelihood diversification – weather-indexed crop insurance	– prevents damaging coping strategies as a result of risks to weather-dependent livelihoods
Promotive (building adaptive capacity)	– social transfers – access to credit – asset transfers/protection – starter packs (drought/flood resistant) – access to common property resources – public works programmes	– promotes resilience through livelihood diversification and security to withstand climate related shocks – promotes opportunities arising from climate change
Transformative (building adaptive capacity)	– promotion of minority rights – anti-discrimination campaigns – social funds	– transforms social relations to combat discrimination underlying social and political vulnerability

Source: Davies et al., 2009a

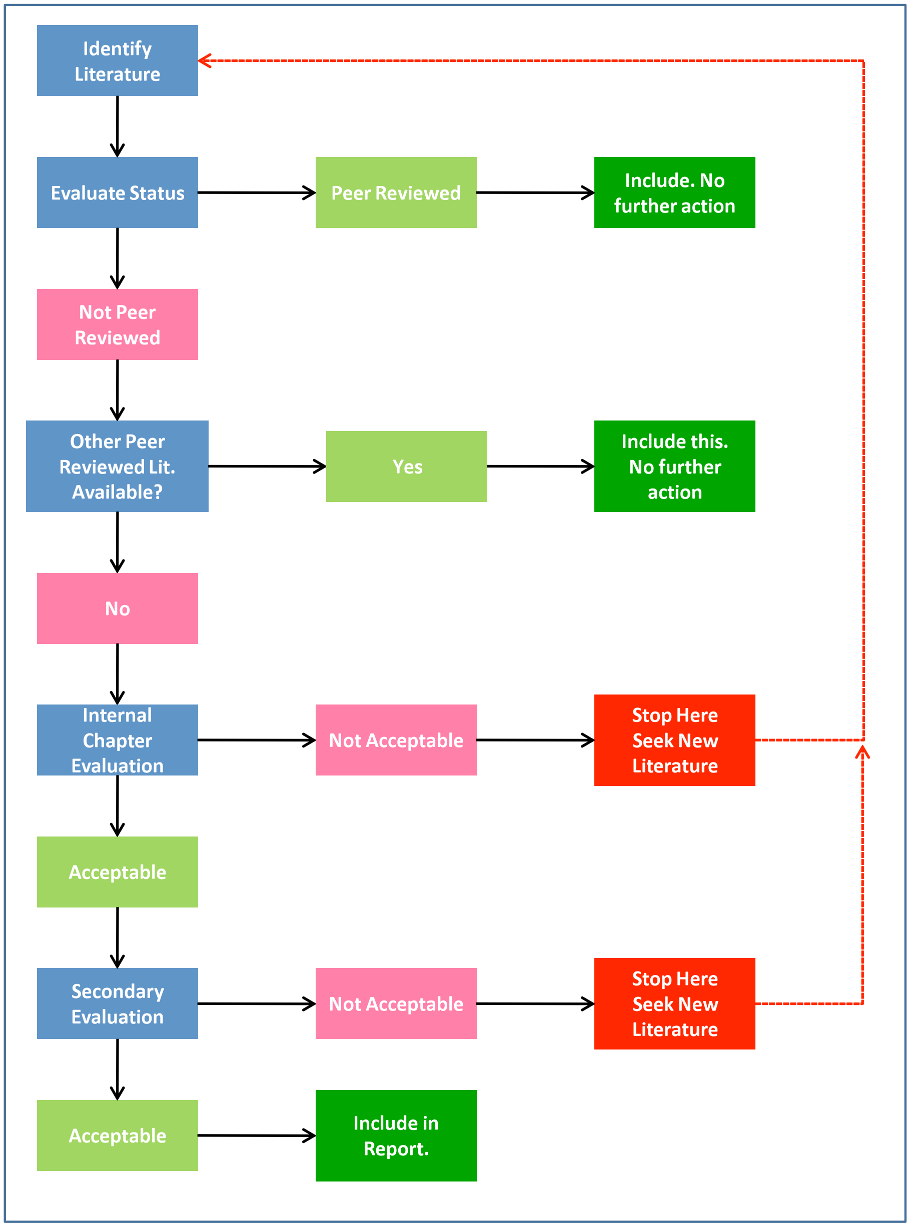

Figure 5-1: Procedure for assessing grey literature.

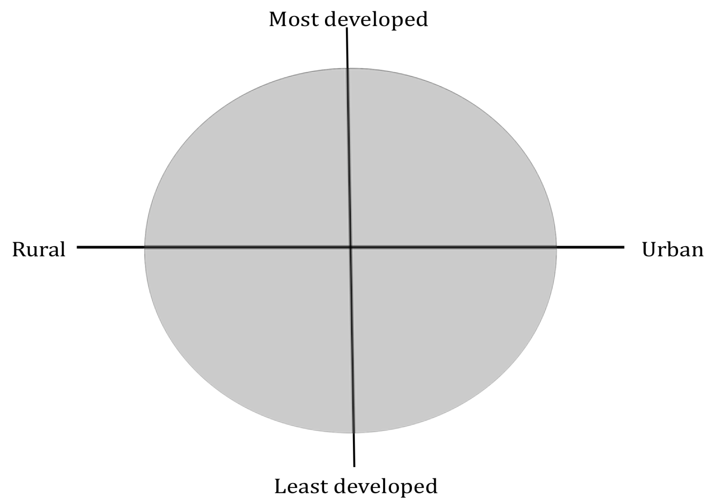

Figure 5-2: The Continuum of development and urbanization.

Figure 5-3: Earth embankment along the river (left) with stabilization (right) (ADPC, 2005).

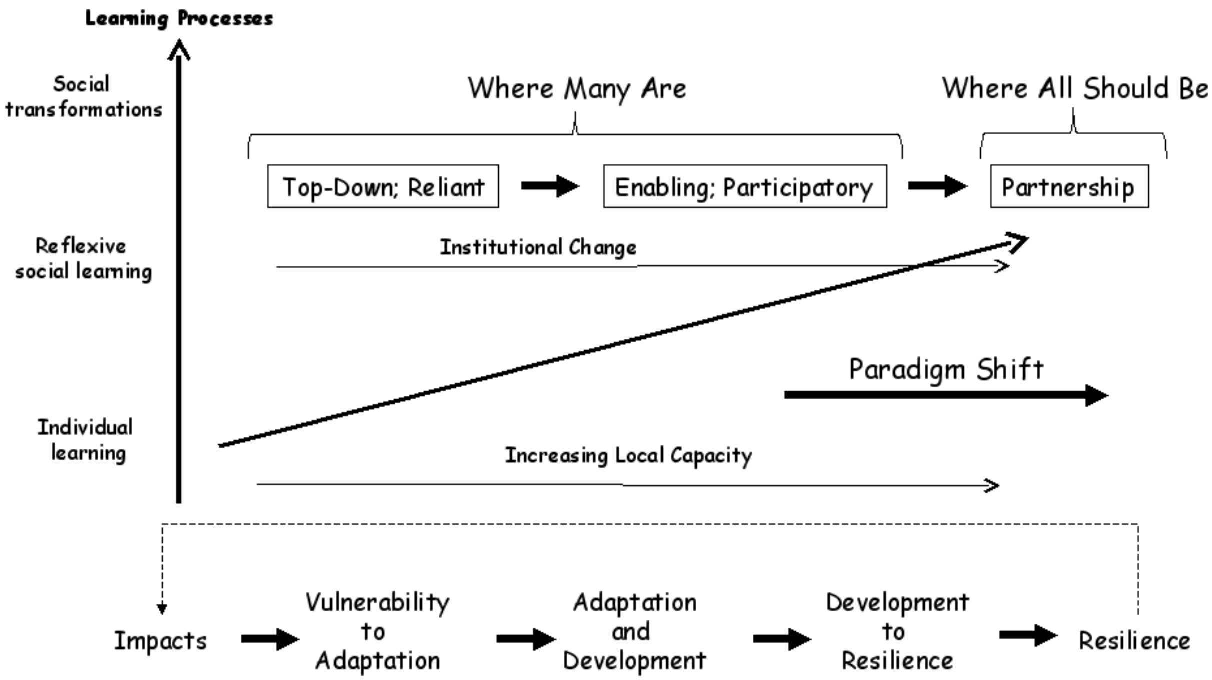

Figure 5-4: Dimensions of the adaptation continuum (O'Brien et al. 2009).