

## Chapter 8. Toward a Sustainable and Resilient Future

### Coordinating Lead Authors

Karen O'Brien (Norway), Mark Pelling (UK), Anand Patwardhan (India)

### Lead Authors

Stephane Hallegatte (France), Andrew Maskrey (Switzerland), Taikan Oki (Japan), Úrsula Oswald-Spring (Mexico), Thomas Wilbanks (USA), Pius Zebhe Yanda (Tanzania)

### Review Editors

Carlo Giupponi (Italy), Nobuo Mimura (Japan)

### Contributing Authors

Frans Berkhout (Netherlands), Reinette (Oonsie) Biggs (South Africa), Hans Günter Brauch (Germany), Katrina Brown (UK), Carl Folke (Sweden), Lisa Harrington (USA), Howard Kunreuther (USA), Carmen Lacambra (Colombia), Robin Leichenko (USA), Reinhard Mechler (Germany), Claudia Pahl-Wostl (Germany), Valentin Przulski (France), David Satterthwaite (UK), Frank Sperling (Germany), Linda Sygna (Norway), Thomas Tanner (UK), Petra Tschakert (Austria), Kirsten Ulsrud (Norway), Vincent Vignié (France)

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### Executive Summary

**Actions that range from incremental steps to transformational changes are essential for reducing risk from weather and climate extremes (*high agreement, robust evidence*).** [8.6, 8.7] Incremental steps aim to improve efficiency within existing technological, governance and value systems, whereas transformation may involve changes to the systems themselves. The balance between incremental and transformational approaches depends on evolving risk profiles and underlying social and ecological conditions. Disaster risk, climate change impacts and capacity to cope and adapt are unevenly distributed. Vulnerability and loss is often concentrated in poorer countries or groups, although the wealthy can also be vulnerable to extreme events. Where vulnerability is high and adaptive capacity relatively low, changes in extreme climate and weather events can make it difficult for systems to adapt sustainably without transformational changes. Such transformations, where they are required, are facilitated through increased emphasis on adaptive management, learning, innovation and leadership.

**Evidence indicates that disaster risk management and adaptation policy can be integrated, reinforcing and supportive – but this requires careful coordination that reaches across domains of policy and practice (*high agreement, medium evidence*).** [8.2, 8.3, 8.5, 8.7] Including disaster risk management into resilient and sustainable development pathways is facilitated through integrated, systemic approaches that enhance capacity to cope with, adapt to, and shape unfolding processes of change, while taking into consideration multiple stressors, different prioritized values, and competing policy goals.

**Development planning and post-disaster recovery have often prioritized strategic economic sectors and infrastructure over livelihoods and well-being in poor and marginalized communities. This can generate missed opportunities for building local capacity and integrating local development visions into longer-term strategies for disaster risk reduction and adaptation to climate change (*high agreement, robust evidence*).** [8.4.1, 8.5.2] A key constraint that limits pathways to post-disaster resilience is the time-bound nature of reconstruction funding. The degradation of ecosystems providing essential services also limits options for future risk management and adaptation actions locally.

**Learning processes are central in shaping the capacities and outcomes of resilience in disaster risk management, climate change adaptation and sustainable development (*high agreement, robust evidence*).** [8.6.3, 8.7] An iterative process of monitoring, evaluation, learning, and innovation can reduce disaster risks and promote adaptive management in the context of extremes. Technological innovation and access may help achieve resilience, especially when combined with capacity development anchored in local contexts.

**Progress towards resilient and sustainable development benefits from leadership that questions assumptions and paradigms and that encourages innovation and the generation of new patterns of response (*medium agreement, robust evidence*).** [8.2.5, 8.6.3.4, 8.7] Responding successfully to multiple stressors, including disaster risk, often involves broad participation in strategy development, the capacity to combine multiple perspectives and differing worldviews, and contrasting ways of organizing social relations.

**Multi-hazard risk management approaches provide opportunities to reduce complex and compound hazards in rural and urban contexts (*high agreement, robust evidence*).** [8.2.5, 8.5.2, 8.7] Considering multiple types of hazards reduces the likelihood that risk reduction efforts targeted at one type of hazard will enhance risk to other hazards, both in the present and future. Building adaptation into multi-hazard risk management involves consideration of current climate variability and projected changes in climate extremes, which pose different challenges to affected human and natural systems than changes in the means. Where changes in extremes cause greater stresses on human and natural systems, direct impacts may be more unpredictable, increasing associated adaptation challenges.

**Short-term and long-term perspectives on both disaster risk management and adaptation to climate change can be difficult to reconcile (*high agreement, medium evidence*).** [8.2.1, 8.3.1, 8.3.2, 8.5.1, 8.6.1] There are trade-offs between current decisions and long-term goals linked to diverse values, interests, priorities and visions for the future. Reconciling short-term and long-term goals for vulnerability reduction involves overcoming the disconnect between local risk management practices and national institutional and legal frameworks, policy and planning. Resilience thinking also offers some tools for reconciling short-term and long-term responses, including integrating different types of knowledge, an emphasis on inclusive governance, and principles of adaptive management. The most attractive adaptation and disaster risk reduction actions are those that offer development benefits in the relatively near term, as well as reductions in vulnerability in the longer-term. However, limits to resilience are faced when social and/or natural systems exceed thresholds or tipping points.

**Building a strong foundation for integrating disaster risk management and adaptation to climate change includes making transparent the values and interests that underpin development, including who wins and loses from current policies and practices, and the implications for human security (*high agreement, medium evidence*).** [8.2.3, 8.2.4, 8.4.2, 8.4.3, 8.6.1.2] Both disaster risk management and adaptation to climate change share challenges related to 1) reassessing and potentially transforming the goals, functions and structure of institutions and governance arrangements; 2) creating synergies across temporal and spatial scales; and 3) increasing access to information, technology, resources and capacity. These challenges are particularly demanding in countries and localities with the highest climate-related risks and weak capacities to manage those risks. Countries with significant capacity and strong risk management records also benefit from addressing these challenges.

**A prerequisite for sustainability is addressing the underlying causes of vulnerability and the structural inequalities that create and sustain poverty and constrain access to resources (*medium agreement, robust evidence*).** [8.6.2.3, 8.7] This involves integrating disaster risk management in other social and economic policy domains, as well as a long-term commitment to managing risk.

**The dynamics among climate change mitigation, adaptation and disaster risk management will have a major influence on resilient and sustainable pathways (*high agreement, low evidence*).** [8.2.5, 8.5.2, 8.7] Trade-offs and synergies between the goals of mitigation and adaptation in particular will play out locally, but have global consequences.

**There are many approaches and pathways to a sustainable and resilient future. Multiple approaches and development pathways can increase resilience to climate extremes (*medium agreement, medium evidence*).** [8.2.3, 8.4.1, 8.6.1, 8.7] Choices and outcomes for adaptive actions to climate extremes must reflect divergent capacities and resources and multiple interacting processes. Actions are framed by trade-offs between competing prioritized values and objectives, and different visions of development that can change over time. Iterative, reflexive approaches allow development pathways to integrate risk management so that diverse policy solutions can be considered as risk contexts evolve over time. Choices made today can exacerbate current or future vulnerability, and facilitate or constrain future responses.

## 8.1. Introduction

This chapter focuses on the implications of changing climate extremes for development, and considers how disaster risk management and climate change adaptation together can contribute to a sustainable and resilient future. Changes in the frequency, timing, magnitude and characteristics of extreme events pose challenges to the goals of reducing disaster risk and vulnerability, both in the present and in the future (see Chapter 3). Enhancing the capacity of social-ecological systems to cope with, adapt to, and shape change is central to building sustainable and resilient development pathways in the face of climate change. A concern for social-ecological systems recognizes the interdependence of social and ecological factors in the generation and management of risk, as well as in the pursuit of sustainable development. Despite twenty years on the policy agenda, sustainable development remains contested and elusive (Hopwood *et al.*, 2005). However, within the context of climate change, it is becoming increasingly clear that the sustainability of humans on the Earth is closely linked to resilient social-ecological systems, which is influenced by social institutions, human agency and human capabilities (Pelling, 2003a; Bohle *et al.*, 2009; Adger *et al.*, 2011).

Extremes are translated into impacts by the underlying conditions of exposure and vulnerability associated with development contexts. For example, there is robust evidence that institutional arrangements and governance weaknesses can transform extreme events into disasters (Ahrens and Rudolph, 2006; Hewitt, 1997; Pelling, 2003a; Wisner *et al.*, 2004). The potential for concatenated global impacts of extreme events continues to grow as the world's economy becomes more interconnected, but in relative terms most impacts will occur in contexts with severe environmental, economic, technological, cultural, and cognitive limits to adaptation (see Chapter 5, Section 5.5.3). In relation to extreme events, global risk assessments show that social losses--as well as economic losses as a proportion of livelihood or GDP-- are disproportionately concentrated in developing countries, and within these countries in poorer communities and households (UNDP, 2004; ISDR, 2009; World Bank, 2010a, UNISDR, 2011).

The chapter recognizes that outcomes of changing extreme events depend on responses and approaches to disaster risk reduction and climate change adaptation, both of which are closely linked to development processes. The assessment of literature presented in this chapter shows that changes in extreme events call for greater alignment and integration of climate change responses and sustainable development strategies, and that this alignment depends on greater coherence between short-term and long-term objectives. Yet there are different interpretations of development, different preferences and prioritized values and motivations, different visions for the future, and many trade-offs involved. Research on the resilience of social-ecological systems provides some lessons for addressing the gaps between these objectives. Transformative social, economic, and environmental responses can facilitate disaster risk reduction and adaptation (see Box 8-1). Transformations often include questioning of social values, institutions, and technical practices (Loorbach *et al.*, 2008; Hedrén and Linnér, 2009; Pelling 2010a). A resilient and sustainable future is a choice that involves proactive measures that promote transformations, including adaptive management, learning, innovation, and leadership capacity to manage risks and uncertainty.

\_\_\_\_\_ START BOX 8-1 HERE \_\_\_\_\_

### Box 8-1. Transformation in Response to Changing Climate Extremes

Transformation involves fundamental changes to the attributes of a system, including value systems; regulatory, legislative or bureaucratic regimes; financial institutions; and technological or biophysical systems (see SREX glossary). This chapter focuses on the transformation of disaster risk management systems in the context of climate extremes, through integration with climate change adaptation strategies and wider systems of human development. This is similar to, yet distinct from other types of transformation associated with climate change. For example, there have been attempts to understand climate change and development failures by identifying the scope for political (Harvey, 2010), social (Kovats *et al.*, 2005), economic (Jackson, 2009) and value (Leiserowitz *et al.*, 2006) transformation, and so to for disaster risk management (Klein, 2007). Across these cases, observed processes of stasis and change are analogous (often using common language), but actors and objectives are distinct. That said, transformation in wider political, economic, social and ethical systems can open or close policy space for a more

resilient and sustainable form of disaster risk management (Birkland, 2006), just as acts aimed at transformation in managing climate extremes can have implications for wider systems. This is particularly true where contemporary development goals, paths and hierarchies are identified and addressed as part of the root or proximate causes of vulnerability and risk, i.e., when they are seen as part of the solution for building resilient and sustainable futures (Wisner, 2003; Pelling, 2010a). Although there has been some research on how and why social lock-in makes it difficult to move away from established development priorities and trajectories (Pelling and Manuel-Navarrete, 2011), there has been only limited academic work to date on the ways in which wider transformations impact on disaster risk management, and vice versa.

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Below, we assess a broad literature presenting insights on how diverse understandings and perspectives on disaster risk reduction and climate change adaptation can help to promote a more sustainable and resilient future. Drawing on many of the key messages from earlier chapters, the objective is to assess scientific knowledge on the incremental and transformative changes needed, particularly in relation to integrating disaster risk reduction and climate change adaptation into development policies and pathways. Bringing together experience from a range of disciplines, this chapter identifies proven pathways that can help move from an incremental approach to an integrative approach that also embraces transformation. This is illustrated in Figure 8.1, which depicts resilience as a moving target that is positioned somewhere between the acceptability of residual risk and the costs of risk management. The target moves as the relationship between risk and uncertainty changes (driven by climate extremes, as well as development trends such as urbanization) in relation to the capacity for risk management (which integrates climate change adaptation, disaster risk management and development). As risk and uncertainty increase, incremental adjustments to practices may no longer be sufficient to achieve resilience, and at some point the growing resilience gap will provoke a search for transformative solutions. Through enhanced experimentation and learning approaches, climate change adaptation, disaster risk management and development may provide a pathway for keeping pace with the dynamic drivers and expressions of risk.

[INSERT FIGURE 8-1 HERE:

Figure 8-1: Incremental and transformative pathways to resilience.]

After this introduction (8.1), this chapter discusses the relationship between disaster risk management, climate change adaptation, and sustainable and resilient development (8.2), highlighting the synergies and conflicts between these objectives and the common obstacles to reach them (8.2.1) and the specific role of ecosystems and biodiversity (8.2.2). In particular, it emphasizes the importance of values and perceptions (8.2.3) and the role of technologies (8.2.4) in designing sustainability policies. Finally, it highlights the importance of trade-offs between time scales, spatial scales and multiple stressors (8.2.5).

Focusing on time perspectives, Section 8.3 then discusses options to integrate short- and long-term objectives, by looking at the long-term consequences of present-day responses to disasters (8.3.1), investigating the barriers in integrating short- and long-term response (8.3.2), and proposing options to overcome these barriers and promote resilience (8.3.3).

Section 8.4 assesses the implications of disaster risk reductions and climate change adaptation for equity and access to resources, and in particular the importance of capacities and resource availability to implement policies for adaptation and disaster risk reduction (8.4.1). It also highlights the existence of losers and winners from disasters and disaster risk reduction and adaptation policies (8.4.2), and the consequences of these distributive effects for human security (8.4.3) and for the possibility to achieve international goals such as the Millennium Development Goals (8.4.4).

Section 8.5 focuses on the specific issue of combining disaster risk management and adaptation with climate change mitigation policies. It starts by stressing the role of thresholds and tipping points as limits to what can be achieved in terms of disaster risk management and adaptation, and thus the importance of considering the three policies together (8.5.1). It then discusses synergies and conflicts between mitigation, adaptation, and disaster risk management in urban and rural areas (8.5.2).

Section 8.6 identifies the tools and options to promote resilience to climate extremes and combine adaptation, disaster risk management, and other policy goals. It first discusses various approaches to planning for the future, including the use of scenarios (8.6.1). It then highlights the existence of a continuum of options to make progress over the short and long term, from incremental to transformational changes (8.6.2). These increasingly ambitious changes include the use of analysis and modeling tools to improve disaster risk management and adaptation (8.6.2.1), the implementation of new institutional tools (8.6.2.2), and transformational strategies to reach multiple objectives (8.6.2.3). Such transformational changes can be facilitated using a combination of approaches (8.6.3), including adaptive management (8.6.3.1), learning (8.6.3.2), innovation (8.6.3.3), and leadership (8.6.3.4). The chapter concludes (8.7) by discussing synergies between disaster risk reduction and climate change adaptation to achieve a resilient and sustainable future.

## **8.2. Disaster Risk Management as Adaptation: Relationship to Sustainable Development Planning**

Earlier chapters discussed the concepts of and relationship between disaster risk management (including disaster risk reduction) and climate change adaptation. The two concepts and practices overlap considerably and are strongly complementary. Disaster risk management considers hazards other than those that are climate-derived, such as earthquakes and volcanoes, while climate change adaptation considers and addresses vulnerabilities related to phenomena that would not normally be classified as discrete disasters, such as gradual changes in precipitation, temperature, or sea level. Examples of hazards that are addressed by both communities include flooding, droughts and heat waves.

Disaster risk management is increasingly considered as one of the “frontlines” of adaptation, and perhaps one of the most promising arenas for mainstreaming or integrating climate change adaptation into sustainable development planning (Schipper and Pelling, 2006; G. O’Brien et al., 2006; Schipper, 2009; Sperling and Szekely, 2005). However, it requires modifying development policies, mechanisms, and tools, and identifying and responding to those who gain and lose from living with and creating risk. Contested notions of development and hence differing perspectives on sustainable development planning lead to different conclusions about how disaster risk reduction can contribute to adaptation. This section reviews the definitions of some of the key concepts used in this chapter, and considers the roles that ecosystems services, values and perceptions, technologies, and trade offs in decision making can play in influencing sustainable development planning and outcomes. It also considers the trade offs that are involved in decision-making.

### **8.2.1. *Concepts of Adaptation, Disaster Risk Reduction, and Sustainable Development and How they are Related***

Adaptation can be defined as the process of adjustment of actual or expected climatic stimuli or their effects in order to moderate harm or exploit beneficial opportunities (see Chapter 1, Section 1.1.2). Adaptation actions may be undertaken by public or private actors, and can be anticipatory or reactive, and incremental or transformative (Adger *et al.*, 2007; Stafford Smith *et al.*, 2011). In both principle and practice, adaptation is more than a set of discrete measures designed to address climate change; it is an ongoing process that encompasses responses to many factors, including evolving experiences with both vulnerabilities and vulnerability-reduction planning and actions, as well as risk perception (Tschakert and Dietrich, 2010; Weber, 2010; Wolf, 2011).

Adaptive capacity underlies action and is defined in this report as the combination of strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake adaptation. Adaptive capacity can also be described as the capability for innovation and anticipation (Armitage, 2005), the ability to learn from mistakes (Adger, 2003), and the capacity to generate experience in dealing with change (Berkes *et al.*, 2003). Enhancing adaptive capacity under climate change entails paying attention to learning about past, present, and future climate threats, accumulated memory of adaptive strategies, and anticipatory action to prepare for surprises and discontinuities in the climate systems (Nelson *et al.*, 2007).

Adaptive capacity is uneven across and within sectors, regions, and countries (K. O'Brien *et al.*, 2006). Although wealthy countries and regions have more resources to direct to adaptation, the availability of financial resources is only one factor determining adaptive capacity (Moss *et al.*, 2010; Ford and Ford, 2011). Other factors include the ability to recognize the importance of the problem in the context of multiple stresses, to identify vulnerable sectors and communities, to translate scientific knowledge into action, and to implement projects and programs (Moser and Ekstrom, 2010). The capacity to adapt is in fact dynamic and influenced by economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology (Parry *et al.*, 2007). It is particularly important to understand that places with greater wealth are not necessarily less vulnerable to climate impacts and that a socio-economic system might be as vulnerable as its weakest link (Tol and Yohe, 2007; K. O'Brien *et al.*, 2006). Therefore, even wealthy locations can be severely impacted by extreme events, socially, as well as economically, as Europeans experienced during the 2003 heat wave (Salagnac, 2007; see also Chapter 9, Section 9.2.1).

Current adaptation planning in many countries, regions, and localities involves identification of a wide range of options, although the available knowledge of their costs, benefits, wider consequences, potentials, and limitations is still incomplete (NRC, 2010; See Chapter 4, Section 4.6). In many cases, the most attractive adaptation actions are those that offer development benefits in the relatively near term, as well as reductions of vulnerabilities in the longer term (Agrawala, 2005; Klein *et al.*, 2007; McGray *et al.*, 2007; Hallegatte, 2008a; NRC, 2010). This is a lesson already noted, though not always practiced in disaster preparedness and risk reduction (IFRC 2002, Pelling, 2010b). An emerging literature discusses adaptation through the lens of sustainability, recognizing that not all adaptation responses are necessarily benign; there are tradeoffs, potentials for negative outcomes, competing interests, different types of knowledge, and winners and losers inherent in adaptation responses (Eriksen and O'Brien, 2007; Ulsrud *et al.*, 2008; Barnett and O'Neill, 2010; Beckman, 2011; Brown, 2011; Eriksen *et al.*, 2011; Gachathi and Eriksen, 2011; Owuor *et al.*, 2011). Sustainable adaptation is defined as a process that addresses the underlying causes of vulnerability and poverty, including ecological fragility; it is considered a way of generating social transformation, or changes in the fundamental attributes of society that contribute to vulnerability (Eriksen and O'Brien, 2007; Eriksen and Brown, 2011).

Disaster risk can be defined in many ways (see Chapter 1, Section 1.1.2). In general, however, it is closely associated with the concepts of hazards, exposure, and vulnerability. Hazards are defined in this report as the potential occurrence of a natural or human-induced physical event that may cause negative consequences. Exposure is defined as the presence of people, livelihoods, environmental services and resources, infrastructure, and economic, social, and cultural assets in places that could be adversely affected by climate extremes. Hazards and exposure are changing, not only as the result of climate change, but also due to human activities. For example, hazards associated with floods, landslides, storm surges and fires can be influenced by declines in ecosystem services that regulate runoff, erosion, etc. The drainage of wetlands, deforestation, the destruction of mangroves and the changes associated with urban development (such as the impermeability of surfaces and overexploitation of groundwater) are all factors that can modify hazard patterns (MA, 2005; Nicholls *et al.*, 2008; Nobre *et al.* 1991; Nobre *et al.*, 2005). Consequently, most weather-related hazards now have an anthropogenic element (Lavell, 1999, Cardona, 1996).

Vulnerability has many different (and often conflicting) definitions and interpretations, both across and within the disaster risk and climate communities (see Chapter 1, Section 1.1.2; Chapter 2, Section 2.2). Vulnerability can increase or decrease over time as a result of both environmental and socioeconomic changes (Blaikie *et al.*, 1994; Leichenko and O'Brien, 2008). In general, improvements in a country's development indicators have been associated with reduced mortality risk, yet an increase in economic loss and insurance claims (UNDP, 2004; ISDR, 2009; Pielke *et al.* 2008; Schumacher and Strobl, 2008; ECA, 2009; World Bank, 2010a). Indeed, recent evidence confirms that, despite increasing exposure, mortality risk to tropical cyclones and floods is now decreasing globally, as well as in heavily exposed regions like Asia (ISDR, 2011). In contrast, the risk of economic loss is increasing globally because reductions in vulnerability are not compensating for rapid increases in the exposure of economic assets. In the OECD countries, for example, economic losses are increasing at a faster rate than GDP per capita. In other words, the risk of losing wealth in disasters is increasing faster than that wealth is being created (ISDR, 2011). However, some types of development may increase vulnerability or transfer it between social groups, particularly if development is unequal or degrades ecosystem services (Guojie, 2003). Even where growth is more equitable,

vulnerabilities can be generated (for example, when modern buildings are not constructed to prescribed safety standards) (Hewitt, 1997; Satterthwaite, 2007).

Climate change can magnify many preexisting risks through changes in the frequency, severity and spatial distribution of weather-related hazards, as well as through increases in vulnerability due to climate impacts (e.g., decreased water availability, decreased agricultural production and food availability, or increased heat stress) (see Chapter 4, Section 4.4). Like adaptation, disaster risk reduction may be anticipatory (ensuring that new development does not increase risk) or corrective (reducing existing risk levels) (Lavell, 2009). Given expected population increases in hazard prone areas, anticipatory disaster risk reduction is fundamental to addressing the risk associated with future climate extremes. At the same time, investments in corrective disaster risk reduction are required to address the accumulation of exposure and susceptibility to existing climate risks, for example those inherited from past urban planning or rural infrastructure decisions.

Climate change adaptation and disaster risk management (and especially disaster risk reduction) are critical elements of long-term sustainability for economies, societies, and environments at all scales (Wilbanks and Kates, 2010). The generally accepted and most widespread definition of sustainable development comes from the Brundtland Commission Report, which defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). A number of principles of sustainable development have emerged, including the achievement of a standard of human well-being that meets human needs and provides opportunities for social and economic development; that sustains the life support systems of the planet; that broadens participation in development processes and decisions; and that accelerates the movement of knowledge into action in order to provide a wider range of options for resolving issues (WCED, 1987; NRC, 1999; Meadowcroft, 1997; Swart *et al.*, 2003; MA, 2005). Because sustainable development means finding pathways that achieve socio-economic and environmental goals without sacrificing either, it is concept that is fundamentally political (Wilbanks, 1994).

Discussions of relationships between sustainable development and climate change have increased over the past decades (Cohen *et al.*, 1998; Yohe *et al.*, 2007; Bizikova *et al.* 2010). The literature on development has considered how development paths relate to vulnerabilities both to climate change and to climate change policies (e.g., Davis, 2001; Garg *et al.*, 2009), as well as to other hazards. Clearly, some climate change-related environmental shifts are potentially threatening to sustainable development, but they can also help move towards sustainability, especially if the trends or events are severe enough to require significant adjustment of unsustainable development practices or development paths (e.g., the relocation of population or economic activities to less vulnerable areas). In such cases, both disaster risk reduction and climate change adaptation can be important—even essential—contributors to sustainable development.

There are some examples of successful decreases in vulnerability through disaster risk management, but less evidence in relation to climate change adaptation, in part because the ability to attribute observed environmental stresses and responses to climate change is still limited (Fankhauser *et al.*, 1999; Adger *et al.* 2007; Repetto, 2008). In terms of disaster risk reduction, a large number of lives have been saved over the last decade due to improved disaster early warning systems (IFRC, 2005), and to increased development and human welfare (ISDR, 2011). There remains, however, much more that can be done to reduce mortality and counteract growth in the number of people affected by disasters and climate extremes. For example, recent self-assessments of progress by over 100 countries against the objectives of the Hyogo Framework of Action (ISDR, 2009; ISDR, 2011) indicate that few developing countries have conducted comprehensive, accurate and accessible risk assessments, which are a pre-requisite for both anticipatory and corrective disaster risk reduction. Furthermore, the assessment shows that few countries are able to quantify their investment in disaster risk reduction. There are numerous ways to evaluate success of disaster risk management or climate adaptation, including gauging the extent to which the goals of a given action (determined in anticipation of a given environmental stressor) are achieved, independent of whether the environmental stressor materializes. Both climate adaptation and disaster risk management can contribute to responses to changes in extreme events due to climate change, yet neither approach alone is sufficient.

Econometric analyses at the national scale have reached different conclusions about the impact of disasters on economic growth, but the balance of evidence suggests a negative impact. Whereas Noy and Nualsri (2007), Noy



(2009), Hochrainer (2009), Jaramillo (2009), and Raddatz (2007) suggest that the overall impact on growth is negative, Albala-Bertrand (1993) and Skidmore and Toya (2002) argue that natural disasters have a positive influence on long-term economic growth, often due to both the stimulus effect of reconstruction and the productivity effect. As suggested by Cavallo and Noy (2009) and Loayza *et al.* (2009), this difference may arise from the different impacts of small and large disasters, the latter having a negative impact on growth and the former enhancing growth. In any case, whether or not disaster losses translate into other social and economic impacts depends on how each individual disaster is managed (Moreno and Cardona, 2011) which in turn is related to capacities and political priorities. At the local scale, Strobl (2011) investigates the impact of hurricane landfall on county-level economic growth in the United States. This analysis shows that a county that is struck by at least one hurricane in a year sees its economic growth reduced on average by 0.79 percent, and increased by only 0.22 percent the following year. Noy and Vu (2010) investigate the impact of disasters on economic growth at the province level in Vietnam, and find that lethal disasters decrease economic production while costly disasters increase short-term growth. Rodriguez-Oreggia *et al.* (2009) focus instead on poverty and the World Bank's Human Development Index at the municipality level in Mexico. They show that municipalities affected by disasters experienced an increase in poverty by 1.5 to 3.6 percent. Considering these important links between disasters and development, there is a need to consider disaster risk reduction, climate change adaptation and sustainable development in a consistent and integrated framework (Schipper and Pelling, 2006; G. O'Brien *et al.*, 2006).

### 8.2.2. *Sustainability of Ecosystem Services in the Context of Disaster Risk Management and Climate Change Adaptation*

Reducing human pressures on ecosystems and managing natural resources more sustainably can facilitate efforts to mitigate climate change and to reduce vulnerabilities to extreme climate and weather events. The degradation of ecosystems is undermining their capacity to provide ecosystem goods and services upon which human livelihoods and societies depend (MA, 2005; WWF, 2010), and to withstand disturbances, including climate change. There is evidence that the likelihood of collapse and subsequent regime shifts in ecological and coupled social-ecological systems may be increasing in response to the magnitude, frequency, and duration of climate change and other disturbance events (Woodward, 2010, Folke *et al.*, 2004, MA, 2005). Large, persistent shifts in ecosystem services not only affect the total level of welfare that people in a community can enjoy, they also impact the welfare distribution between people within and between generations and hence may give rise to new conflicts over resource use and questions on inter-generational equity as a component of sustainable development (Thomas and Twyman, 2005). They could result in domino effects of increased pressure on successive resource systems, as has been suggested in the case of depletion of successive fish stocks (Berkes *et al.*, 2006). However, the thresholds at which ecosystems undergo regime shifts and the points at which these may catalyse social stress remain largely unknown, partly due to variability over space and time (Scheffer, 2009; Biggs *et al.*, 2009).

Ecosystems can act as natural barriers against climate-related hazardous extremes, reducing disaster risk (Conde, 2001; Scholze *et al.*, 2005). For example, mangrove forests are a highly effective natural flood control mechanism that will become increasingly important with sea level rise, and are already used as a coastal defense against extreme climatic and non-climatic events (Adger *et al.*, 2005). The benefits of such ecosystem services are determined by ecosystem health, hazard characteristics, local geomorphology, and the geography and location of the system with respect to the hazard (Lacambra and Zahedi, 2011). In assessing the ecological limits of adaptation to climate change, Peterson (2009) emphasizes that ecosystem regime shifts can occur as the result of extreme climate shocks, but that such shifts depend upon the resilience of the ecosystem, and are influenced by processes operating at multiple scales. In particular there is evidence that the loss of regulating services (e.g., flood regulation, regulation of soil erosion) erodes ecological resilience (MA, 2005).

Ecosystems and ecosystem approaches can also facilitate adaptation to changing climatic conditions (Conde, 2001; Scholze *et al.* 2005). Conservation of water resources and wetlands that provide hydrological sustainability can further aid adaptation by reducing the pressures and impacts on human water supply, while forest conservation for carbon sinks and alternative sources of energy such as biofuels can reduce carbon emissions and have multiple benefits (Reid, 2006), as can coastal defenses and avalanche protection (Silvestri and Kershaw, 2010). In New York, for example, untreated storm water and sewage regularly flood the streets because the aging sewage system is no

longer adequate. After heavy rains, overflowing water flows directly into rivers and streams instead of reaching water treatment plants. The US Environmental Protection Agency has estimated that around US\$300 billion over 20 years would be needed to upgrade sewage infrastructure across the country (ISDR, 2011). In response New York City will invest USD 5.3 billion in green infrastructure on roofs, streets and sidewalks. This promises multiple benefits: The new green spaces may absorb more rainwater and reduce the burden on the city's sewage system, improve air quality, and reduce water and energy costs. Such changes in the constituents of an ecosystem can be used as levers to enhance the resilience of coupled social-ecological systems (Biggs *et al.*, 2009).

Biodiversity is also important to adaptation. Functionally diverse systems have more scope to adapt to climate change and climate variability than functionally impoverished systems (Lacambra and Zahedi, 2011, Elmqvist *et al.*, 2003; Hughes *et al.*, 2003). A larger gene pool will facilitate the emergence of genotypes that are better adapted to changed climatic conditions. Conservation of biodiversity and maintenance of ecosystem integrity may therefore be a key objective in improving the adaptive capacity of society to cope with climate change extremes (Peterson *et al.*, 1997; Elmqvist *et al.*, 2003; Secretariat of the Convention on Biological Diversity, 2010).

Strategies that are adopted to reduce climate change through greenhouse gas mitigation can affect biodiversity both negatively and positively (Edenhofer *et al.*, 2011), which in turn influences the capacity to adapt to climate extremes. For example, some bio-energy plantations replace sites with high biodiversity, introduce alien species and use damaging agrochemicals which in turn may reduce ecosystem resilience and hence their capacity to respond to extreme events (Fargione *et al.*; 2009, Foley *et al.*, 2005). Large hydropower schemes can cause loss of terrestrial and aquatic biodiversity, inhibit fish migration and lead to mercury contamination (Montgomery *et al.*, 2000), as well as change watershed sediment dynamics, leading to coastal areas sediment starvation which in turn could lead to coastal erosion and make coasts more vulnerable to sea level rise and storm surges (Silvestri and Kershaw, 2010).

The increasing international attention and support for efforts focused on Reducing Emissions from Deforestation and Degradation, maintaining/enhancing carbon stocks and promoting sustainable forest management (REDD+) is an example of where incentives for the protection and sustainable management of natural resources driven by mitigation concerns also has the potential of generating co-benefits for adaptation. By mediating run-off and reducing flood risk, protecting soil from water and wind erosion, providing climate regulation and providing migration corridors for species, ecosystem services supplied by forests can increase the resilience to some climatic changes (Locatelli *et al.*, 2010). Primary forests tend to be more resilient to disturbance and environmental changes, such as climate change, than secondary forests and plantations (Thompson *et al.*, 2009). However, forests are also vulnerable to climatic extremes (Nepstad *et al.*, 2007) and the modeled effects of global warming (Vergara and Scholz, 2011). Hence, the role of forest ecosystems in climate change mitigation and adaptation will itself depend on the rate and magnitude of climate change and whether the crossing of ecological tipping points can be avoided.

### 8.2.3. *The Role of Values and Perceptions in Shaping Response*

Values and perceptions are important in influencing action on climate change extremes, and they can have significant implications for sustainable development. The disaster risk community has used several points of view for resolving decisions about where to invest limited resources, including considerations of economic rationality and moral obligation (Sen, 2000). Value judgments are embedded in problem framing, solutions, development decisions, and evaluation of outcomes, thus it is important to make them explicit and visible. Values describe what is desirable or preferable, and they can be used to represent the subjective, intangible dimensions of the material and nonmaterial world (O'Brien and Wolf, 2010). They are closely linked to worldviews and beliefs, including perceptions of change and causality (Rohan 2000; Leiserowitz 2006; Weber 2010). Values both inform and are shaped by action, judgment, choice, attitude, evaluation, argument, exhortation, rationalization, and attribution of causality (Rokeach, 1979). However, values do not always clearly translate to particular behaviors (Leiserowitz *et al.*, 2005). Recognizing and reconciling conflicting values increases the need for inclusiveness in decision-making and for finding ways to communicate across social and professional boundaries (Rosenberg, 2007; Vogel *et al.*, 2007; Oswald Spring and Brauch, 2011).

Losses from extreme events can have implications beyond objective, measurable impacts such as loss of lives, damage to infrastructure, or economic costs. They can lead to a loss of what matters to individuals, communities, and groups, including the loss of elements of social capital, such as sense of place or of community, identity, or culture. This has long been observed within the disaster risk community (Hewitt, 1997; Mustafa, 2005) and in more recent work in the climate change community (O'Brien, 2009; Adger et al., 2010; Pelling, 2010a). A values-based approach recognizes that socio-economic systems are continually evolving, driven by innovations, aspirations and changing values and preferences of the constituents (Simmie and Martin, 2010; Hedlund-de Witt, 2011). This approach raises not only the ethical question of 'Whose values count?', but also the important political question of 'Who decides?'. These questions have been asked in relation to both disaster risk (Blaikie et al., 1994; Wisner, 2003; Wisner et al., 2004) and climate change (Adger, 2004; Hunt and Taylor, 2009; Adger et al., 2010; O'Brien and Wolf, 2010), and are significant when considering the interaction of climate change and disaster risk, including the complexity of the temporal consequences of policies and decisions (Pelling, 2003a).

The probabilistic risk assessments that form the basis for current models of cost-benefit analysis (CBA) rarely take into account the wider consequences that account for a substantial proportion of disaster damage for poorer households and communities (Marulanda et al., 2010; ISDR, 2004, 2009). These include outcomes such as increased poverty and inequality (de la Fuente et al., 2009; Hallegatte, 2006), health effects (Murray and Lopez, 1996; Grubb et al., 1999; Viscusi et al., 2003), cultural assets and historical building losses (ICOMOS, 1993), environmental impacts, which are often very difficult to measure in monetary terms. Specific approaches allow to account for distributive effects in CBA (e.g., distributional-weight CBA, see Harberger, 1978; basic-needs CBA, see Harberger, 1984; or social welfare function built as a sum of individual welfare function that increases nonlinearly with income), but none of them is consensual. Other types of valuation emphasize institutional elements such as the 'moral economy' associated with the collective memory and identities of people living in non-western cultures in many parts of the world (Scott, 2003; Rist, 2000; Hughes, 2001; Trawick, 2001).

Two important philosophical value frameworks have dominated attempts to establish priorities for risk management: human rights and utilitarian approaches. Human rights-based approaches (Gardiner, 2010; Wisner, 2003) emphasize moral obligation to reduce avoidable risk and contain loss, which was recognised in the UN Universal Declaration of Human Rights in 1948: Article 3 provides for the right to 'life, liberty and security of person', while Article 25 protects 'a standard of living adequate for the health and well-being... in the event of unemployment, sickness, disability, widowhood, or old age or other lack of livelihood in circumstances beyond his [sic] control'. The humanitarian community, and civil society more broadly, has made considerable progress in addressing these aspirations (Kent, 2001), perhaps best exemplified by the Sphere standards. These are a set of self-imposed guidelines for good humanitarian practices that require impartiality in post-disaster actions including shelter management, access and distribution to relief and reconstruction aid (Sphere, 2004). The ethics and equity dimensions of risk management have also been explored in adaptation through the application of Rawls' theory of justice (Rawls, 1971; Paavola, 2005; Paavola and Adger 2006; Paavola et al., 2006; Grasso, 2009, 2010). From this perspective, priority is given to reducing risk for the most vulnerable, even if this limits the absolute numbers who benefit.

In contrast to focusing on the most excluded or economically poor, utilitarian approaches assume that interpersonal welfare comparisons are possible, and that a social welfare function that summarizes the welfare of a population can be built (Pigou, 1920). Assuming its existence, maximizing this social welfare function reveals where economic benefits of public investments exceed costs. The calculated economic benefits of investing in risk reduction vary, but are often considered significant (see Ghesquiere et al., 2006; World Bank 2010a; ISDR, 2011). There are, however, extreme difficulties in accounting for the complexity of disaster costs and risk reduction investment benefits (Pelling *et al.*, 2002; Hallegatte and Przulski, 2011). A key point here is that value frameworks can significantly influence the types of responses to climate and weather extremes.

#### 8.2.4. *Technology Choices, Availability, and Access*

Technology choices can contribute to both risk reduction and risk enhancement, relative to extreme climate and weather events. As discussed in Chapter 7, Section 7.4.3, technologies receive prominent attention in both climate

change adaptation and disaster risk reduction. Continuing transitions from one socio-technological state to another frame many aspects of responses to climate change risks. Assessments of roles of technology choices, availability and access in responding to climate extremes are enmeshed in a wide range of technologies that must be considered within a broad range of development contexts. However, in nearly every case issues are raised about the balance between risk reduction and risk creation. Technology is a broad concept that embraces a range of areas, including information and communication technologies, roads and infrastructure, food and production technologies, energy systems, and so on. Technology choices can alleviate disaster risk, but they can also significantly increase risks and add to adaptation challenges (Jonkman *et al.*, 2010). For example, some modern energy systems and centralized communication systems are dependent on physical structures that can be vulnerable to storm damage. It has been suggested that relatively centralized high-technology systems are “brittle,” offering efficiencies under normal conditions but subject to cascading effects in the event of emergencies (Lovins and Lovins, 1982).

In many cases, technologies are considered to be an important part of responses to climate extremes and disaster risk. This includes, for example, attention to physical infrastructure, including how to “harden” built infrastructures such as bridges or buildings, or natural systems such as hillsides or river channels, such that they are able to withstand higher levels of stress (Larsen *et al.*, 2007; CCSP, 2008; UNFCCC, 2006). Another focus is on technologies that assist with information collection and diffusion, including technologies to monitor possible stresses and vulnerabilities, technologies to communicate with populations and responders in the event of emergencies, and technology applications to disseminate information about possible threats and contingencies – although access to such technologies may be limited in some developing regions. Seasonal climate forecasts based on the results from numerical climate models have been developed in recent decades to provide multi-month forecasts, which can be used to prepare for floods and droughts (Stern and Easterling, 1999). Modern technological development is exploring a wide variety of innovative concepts that may eventually hold promise for disaster risk reduction, for example through new food production technologies, although ecological, ethical and human health implications are often as yet unresolved (Altieri and Rosset, 1999).

Attention to technology alternatives and their benefits, costs, potentials, and limitations in cases where disaster risk is created and when risk reduction takes place involve two different time horizons. In the near term, technologies to be considered are those that currently exist or that can be modified relatively quickly. In the longer term, it is possible to consider potentials for new technology development, given identified needs (Wilbanks, 2010). In some circumstances, technologies put in place to reduce short-term risk and vulnerability can increase future vulnerability to extreme events or ongoing trends. For example, the use of irrigation has reduced farmer vulnerabilities to low and variable precipitation patterns. However, when the irrigation water is from a non-renewable source (e.g., the Ogallala-High Plains aquifer system of the U.S), the foreseeable reduction in future irrigation opportunities would mean an increase in vulnerability and the risk of increasing crop failures (AAG, 2003; Harrington, 2005).

Similarly, while large dams could mitigate drought and generate electricity, well known costs of social and ecological displacement may be unacceptable (Baghel and Nusser, 2010). Furthermore, unless dams are constructed to accommodate future climate change, they may present new risks to society by encouraging a sense of security that ignores departures from historical experience (Wilbanks and Kates, 2010). In the Mekong region, dykes, dams, drains and diversions established for flood protection have unexpected consequences on risk over the longer term, because they influence risk-taking behavior (Lebel *et al.*, 2009). In the United States, past building in floodplain areas downstream from dams that have now exceeded their design life has become a major concern; tens of thousands of dams are now considered as having high hazard potential (ASCE, 2010; FEMA, 2009; McCool, 2005).

Investments in physical infrastructure cast long shadows through time, because they tend to assume lifetimes of three to four decades or longer. The gradual modernization of a city’s housing stock, transport or water and sanitation infrastructure takes many decades without targeted planning. If they are maladaptive rather than adaptive, the consequences can be serious. This suggests a re-appraisal of technology that might promote more distributed solutions, for example multiple, smaller dams that can resolve local as well as more distant needs, widely spread, local energy production (perhaps utilizing micro-solar, wind and water or geothermal power) can reduce exposure to secondary impacts from natural disaster when large power generators or power transmission lines are lost during natural disaster, or when power plants generate secondary disasters after being impacted by a natural hazard, as has happened recently in Japan. The goal of a more distributed and less maximizing development vision has been

expressed in Thailand's "Sufficiency Economy" approach, where local development is judged against its contribution to local, national and international wealth generation (UNDP, 2007a).

Technology choices, availability and access depend on more than technology development alone. Unless the technologies, the skills required to use them, and the institutional approaches appropriate to deploy them are effectively transferred from providers to users ("technology transfer"), the effects of technology options, however promising, are minimized (see Chapter 7, Section 7.4.3). Challenges in putting science and technology to use for sustainable development have received considerable attention (e.g., Nelson and Winter, 1982; Patel and Pavit, 1995; NRC, 1999; International Council for Science, 2002; and Kristjanson et al., 2009), emphasizing the wide range of contexts that shape both barriers and potentials. If obstacles related to intellectual property rights can be overcome, however, the growing power of the information technology revolution could accelerate technology transfer (linked with local knowledge) in ways that would be very promising (Wilbanks and Wilbanks, 2010).

### 8.2.5. *Tradeoffs in Decision Making: Addressing Multiple Scales and Stressors*

Sustainable development involves finding pathways that achieve a variety of socioeconomic and environmental goals, without sacrificing any one for the sake of the others. As a result, the relationships between adaptation, disaster risk management and sustainability are highly political. Successful reconciliation of multiple goals "lies in answers to such questions as who is in control, who sets agendas, who allocates resources, who mediates disputes, and who sets rules of the game" (Wilbanks, 1994: 544). This means that conflicts of interest must be acknowledged and addressed, whether they are between government departments, sectors, or policy arenas, and suggests that simple panaceas are unlikely without tradeoffs in decision-making (Brock and Carpenter, 2007).

There is no single or optimal way of adapting to climate change or managing risks, because contexts for risk management vary so widely. For example, risk management decisions can be oriented toward incremental responses to frequent events that are disruptive but perhaps not "extreme." Often, trade-offs between multiple objectives are ambiguous. For example, focusing on and taking actions to protect against frequent events may lead to greater vulnerability to larger and rarer extreme events (Burby, 2006). This is a particular challenge for investing in fixed physical infrastructure. Social investments and risk awareness, including early warning systems, can be strengthened by more frequent low impact events that maintain risk visibility and allow preparedness for larger, less frequent events (See Chapter 9, Sections 9.2.11 and 9.2.14). Pielke *et al.* (2007) also warn that locating adaptation policy in a narrow risk framework through concentrating only on identifiable anthropogenic risks can distort public policy because vulnerabilities are created through multiple stresses.

As one salient example, during disaster reconstruction tensions frequently arise between demands for speed of delivery and sustainability of outcome. Response and reconstruction funds tend to be time limited, often requiring expenditure within 12 months or less from the point of disbursement. This pressure is compounded by multiple agencies working with often limited coordination. Time pressure and competition between agencies tends to promote centralised decision-making and the sub-contracting of purchasing and project management to non-local commercial actors. Both outcomes save time but miss opportunities to include local people in decision-making and learning from the event with the resulting reconstruction in danger of failing to support local cultural and economic priorities (Berke *et al.*, 1993; Pearce, 2003). At the same time it is important not to romanticise local actors or their viewpoints, which might at times be unsustainable or point to maladaptation, or to accept local voices as representative of all local actors. When successful, participatory reconstruction planning has been shown to build local capacity and leadership, bind communities and provide mechanisms for information exchange with scientific and external actors (Lyons *et al.*, 2010). As part of any participatory or community based reconstruction, the importance of a clear conflict resolution strategy has been recognized.

Trade-offs may also arise through conflicts between economic development and risk management (Kahl, 2003, 2006). The current trend of development in risk-prone areas (e.g., coastal areas in Asia) is driven by socio-economic benefits yielded by these locations, with many benefits accruing to private investors or governments through tax revenue. For example, export-driven economic growth in Asia favours production close to large ports to reduce transportation time and costs. Consequently, the increase in risk has to be balanced against socio-economic gains of

development in at-risk areas. Additional construction in at-risk areas is not unacceptable *a priori*, but has to be justified by other benefits, and sometimes complemented by other risk-reducing actions (e.g., early warning and evacuation, improved building norms, specific flood protection). This introduces the possibility for those benefiting financially to offset produced risk through risk reduction mechanisms ranging from fair wages and disaster resistant housing (to enhance worker resilience) to support for early-warning, preparedness and reconstruction. Such approaches have been considered in some businesses through corporate social responsibility agendas (Twigg, 2001).

One climate change/development trade-off linked both to time frames and the magnitude of climate extremes is the future need for risk reduction infrastructure that would require changes in ecologically or historically important areas. For example, when considering additional protection (e.g., dykes and seawalls) in historical centres, aesthetic and cultural elements as well as building costs will be taken into account. Existing planning and design standards to protect cultural heritage or ecological integrity may need to be balanced with the needs of adaptation (Hallegatte *et al.*, 2011a). Difficulties in attributing value to cultural and ecological assets mean that cost-benefit analyses are not the best tool to approach these type of problems. Multi-criteria decision-making tools (Birkmann, 2006) that incorporate a participatory element and can recognise the political, ethical, and philosophical aspects of such decisions can also be useful (Mercer *et al.*, 2008). But the magnitude of emerging climate extremes is an important issue. If climate change is relatively severe, rather than moderate, then the focus on preserving iconic areas is likely to increase, as will the costs.

Another contextual complication that introduces tradeoffs is the fact that impacts of climate change extremes extend across multiple scales. The challenge is to find ways to combine the strengths of addressing multiple scales, rather than having them work against each other (Wilbanks, 2007, 2009). Local scales offer potentials for bottom-up actions that assure participation, flexibility, and innovativeness. At the same time, efforts to develop initiatives from the bottom up are often limited by a lack of information, limited resources, and limited awareness of larger-scale driving forces (AAG, 2003). Larger scales offer potentials for top-down actions that assure resource mobilization and cost-sharing. Integrating these kinds of assets across scales is often essential for resilience to extremes, but in fact integration is profoundly impeded by differences in who decides, who pays, and who benefits; and perceptions of scalar effects that often reflect striking ignorance and misunderstanding (Wilbanks, 2007). In recent years, there have been a number of calls for innovative co-management structures that cross scales in order to promote sustainable development (e.g., Bressers and Rosenbaum, 2003; Cash *et al.*, 2006; Campbell *et al.*, 2010).

What might be done to realize potentials for integrating actions at different scales, to make them more complementary and reinforcing? Many top-down interventions (from international donor development and disaster response and reconstruction funding to new adaption fund mechanisms and national programming) may unintentionally discourage local action by imposing bureaucratic conditions for access to financial and other resources (Christoplos *et al.*, 2009). Top-down sustainability initiatives are often preoccupied with *input* metrics, such as criteria for partner selection and justifications (often based on relatively detailed quantitative analyses of such attributes as “additionality”), rather than on *outcome* metrics such as whether the results make a demonstrable contribution to sustainability (regarding metrics, see NRC, 2005).

To manage trade-offs and conflicts in an open, efficient and transparent way, institutional and legal arrangements are extremely important. The existing literature on legislation for adaptation at the state level is not comprehensive, but those countries studied lack many of the institutional mechanisms and legal frameworks that are important for coordination at the state level (Richardson *et al.*, 2009). This has been found to be the case for Vietnam, Laos and China (Lin, 2009). In the South Pacific, high exposure to climate change risk has yet to translate into legislative frameworks to support adaptation--with only Fiji, Papua New Guinea and Western Samoa formulating national climate change regulatory frameworks (Kwa, 2009). Without a supporting and implemented national legislative structure, achieving local disaster reduction and climate change adaptation planning can be complicated (la Trobe and Davis, 2005; Pelling and Holloway, 2006; see also Chapter 6, Section 6.4). Still, where local leadership is determined, skilful planning is possible, even without legislation. This has been the experience of Ethekwini Municipality (the local government responsible for the city of Durban, South Africa) which has developed a Municipal Climate Protection Programme with a strong and early focus on adaptation without national level policy or legal frameworks to guide adaptation planning at the local level (Roberts, 2008, 2010).

One way around the challenges of trade-offs is to “bundle” multiple objectives through broader participation in strategy development and action planning, both to identify multiple objectives and to encourage attention to mutual co-benefits. In this sense both the pathway and outcomes of development planning have scope to shape future social capacity and disaster risk management. Policies and actions to achieve multiple objectives include stakeholder participation, participatory governance (IRGC, 2009), capacity-building, and adaptive organizations, including both private and public institutions where there is a considerable knowledge base reflecting both research and practice to use as a starting point (e.g., NRC, 2008). Multi-hazard risk management approaches provide opportunities to reduce complex and compound hazards, both in rural and urban contexts.

### 8.3. Integration of Short-Term and Long-Term Responses to Extremes

When considering the linkages between disaster management, climate change adaptation and development, time-scales play an important role. Disaster management increasingly emphasizes vulnerability reduction in addition to the more traditional emergency response and relief measures. This requires addressing underlying exposure and sensitivity in the context of hazards with different frequencies and return periods. As discussed in Chapter 2, there is now a converging focus on vulnerability reduction in the context of disaster risk management and adaptation to climate change (Sperling and Szekely, 2005).

Cross-scale (spatial and temporal) interactions between responses focusing on the short-term and those required for long-term adjustment can potentially create both synergies and contradictions among disaster risk reduction, climate change adaptation and development. This section assesses the literature regarding synergies and trade-offs between short- and long-term adjustments. First, we consider the implications of present day responses for future well-being. The barriers to reconciling short-term and long-term goals are then assessed. Insights from research on the resilience of social-ecological systems are then considered as a potential means of addressing integration in a long-term perspective.

#### 8.3.1. Implications of Present-Day Responses for Future Well-Being

The implications of present-day responses to both disaster risk and climate change can be either positive or negative for human security and well-being in the long-term. Positive implications can include increased resilience, capacity-building, broad social benefits from extensive participation in risk management and resilience planning, and the value of multi-hazard planning (see Chapter 5, Section 5.4 and Chapter 6, Section 6.5). Negative implications can include threats to sustainability if the well-being of future generations is not considered; issues related to the economic discounting of future benefits; “silo effects” of optimizing responses for one system or sector without considering interaction effects with others (see Burby *et al.*, 2001); equity issues regarding who benefits and who pays; and the “levee effect,” where the adaptive solution to a current risk management problem builds confidence that the problem has been solved, blinding populations to the possibility that conditions may change and make the present adaptation inadequate (Burby, 2006; Burby *et al.*, 2006).

The terms coping and adaptation reflect strategies for adjustments to changing climatic and environmental conditions. In the case of a set of policy choices, both coping and adaptation denote forms of conduct that aim and indeed may achieve modifications in the ways in which society relates to nature, and nature to society (Stehr and von Storch, 2005). As discussed in Chapter 2, Section 2.4, coping actions are those that take place when trying to alleviate the impacts or to live with the costs of a specific event. They are usually found during the unfolding of disaster impacts, which can continue for some time after an event—for example if somebody loses their job or is traumatized. Coping strategies can help to alleviate the immediate impact of a hazard, but may also increase vulnerabilities over the medium to longer term (Swift, 1989; Davies, 1993; Sperling *et al.*, 2008). The different time-frames for coping and adaptation can present challenges for risk management. Focusing on short-term responses and coping strategies can limit the scope for adaptation in the long-term. For example, drought can force agriculturalists to remove their children from school or delay medical treatment, which may have immediate survival benefits, yet in aggregate undermines the human resources available for long-term adaptation (Norris, 2005; Santos, 2007; Alderman *et al.*, 2006; Sperling *et al.*, 2008).

In both developed and developing countries, a focus on coping with the present is often fuelled by the perception that climate change is a long-term issue and other challenges, including economic growth, food security, water supply (Bradley *et al.*, 2006), sanitation, education and health care, require more immediate attention (Adly and Ahmed, 2009; Kameri-Mbote and Kindiki, 2009; Klein *et al.*, 2005). Particularly in poor rural contexts, short-term coping may be a trade-off that increases longer-term risks (ISDR, 2009; Brauch and Oswald Spring, 2011). Adaptation, on the other hand, is often focused on minimizing potential risk to future losses (Oliver-Smith, 2007). This ‘long-term’ framing of adaptation can constrain both short-term coping and adaptive capacity, for example when relocation of settlements to avoid coastal hazards undermines social capital and local livelihoods, limiting household coping and adaptive capacity (Hunter, 2005). There is a large literature and much experience related to slum relocation that is of direct relevance to urban coping and adaptation (Gilbert and Ward, 1984; Davidson *et al.*, 1993; Viratkapan and Perera, 2006). Context is important in discussing trade-offs between addressing short-term and long-term risks, and even in well-governed systems, political expediency will often distort the regulatory process in a way that favors the short term (Platt, 1999).

Disasters can destroy assets and wipe out savings, and can push households into “poverty traps”, i.e. situations where productivity is reduced, making it impossible for households to rebuild their savings and assets (Zimmerman and Carter, 2003; Carter *et al.*, 2007; Dercon and Outes, 2009; López, 2009; van den Berg, 2010). The process by which a series of events generates a vicious spiral of impacts, vulnerability and risk was first recognized by Chambers (1989), who described it as the ratchet effect of disaster, risk and vulnerability. These micro-level poverty traps can also be created by health and social impacts of natural disasters: it has been shown that disasters can have long-lasting consequences on psychological health (Norris, 2005), and on child development from reduction in schooling and diminished cognitive abilities (see Santos, 2007; Alderman *et al.*, 2006; Bartlett, 2008).

Where disaster loss is widespread, micro-level poverty traps can aggregate to the regional level. Here poor regions impacted by disaster are unable to fully recover so that capacity is reduced and vulnerability heightened, making future disasters more likely. Without enough time to rebuild between events, such regions may end up in a state of permanent reconstruction, with resources devoted to repairing and replacing rather than accumulating infrastructure and equipment. This obstacle to capital accumulation and infrastructure development can lead to a permanent disaster-related underdevelopment (Hallegatte *et al.*, 2007; Hallegatte and Dumas, 2008). This can be amplified by other long-term mechanisms, such as changes in risk perception that reduce investments in the affected regions or reduced services that make qualified workers leave the region. These effects have been discussed by Benson and Clay (2004), and investigated by Noy (2009) and Hochrainer (2009), who found that natural disasters have a negative impact on economic growth and development, especially when direct losses are large. This negative impact is found to be larger when the disaster affects a smaller country, with lower GDP per capita, weaker institutions, lower openness to trade, lower literacy rates, and lower levels of government spending, and when foreign and remittances are lower. Such effects have been modeled by Hallegatte *et al.* (2007) and Hallegatte and Dumas (2008) using a reduced-form economic model that shows that the average GDP impact of natural disasters can be either close to zero if reconstruction capacity is large enough, or very large if reconstruction capacity is too limited, which may be the case in less developed countries. There are, however, many uncertainties in the ways in which people’s spontaneous and organised responses to increasing climate-related hazards feed-back to influence long-term adaptive capacity and options. Migration, which can be traumatic for those involved, might lead to enhanced life chances for the children of migrants, building long-term capacities and potentially also contributing to the movement of populations away from places exposed to risk (UNDP, 2009; Ahmed, 2009; Oswald Spring, 2009b; IOM, 2007, 2009a, 2009b).

A broad literature on experiences of community-based and local-level disaster risk reduction indicates options for transiting from short-term to longer-term responses, at least in the context of frequently occurring risk manifestations (ISDR, 2009, Lavell, 2009, Maskrey, 2011). Such approaches, many of which are based on community participation, have progressively moved from addressing disaster preparedness and capacities for emergency management, towards addressing the vulnerability of livelihoods, the decline of ecosystems, the lack of social protection, unsafe housing, the improvement of governance and other underlying risk factors (Bohle, 2009). While managing existing risk will contain loss, addressing underlying risk drivers will contribute to a reduction of future risk to climate extremes.



### 8.3.2. *Barriers to Reconciling Short- and Long-Term Goals*

Although there is robust evidence in the literature to support disaster risk reduction as a strategy for long-term climate change adaptation, there are numerous barriers to reconciling short-term and long-term goals. Many poor countries are very vulnerable to natural hazards but cannot implement the measures that could reduce this vulnerability for financial reasons, or due to a lack of governance capacity or technology. The recent national self-assessments of progress towards achieving the ISDR Hyogo Framework for Action indicated that some Least Developed Countries lack the human, institutional, technical and financial capacities to address even emergency management concerns (ISDR, 2009). A recently-developed index that measures capacities and conditions for risk reduction shows that low- and lower-middle-income countries with weak governance have, with some exceptions, great difficulty addressing underlying drivers of vulnerability. Those at the bottom of the index, such as Haiti, Chad or Afghanistan, are also experiencing conflict or political instability (ISDR, 2011). Another obstacle to reconciling short- and long-term goals is access to technology and maintenance of infrastructure. An example is the introduction of water reuse technologies, which have been developed in a few countries, which could bring a great improvement in the management of droughts if they could be disseminated in many developing countries (Metcalf and Eddy, 2005).

Money and technology are not enough to implement efficient disaster risk reduction and adaptation strategies. Indeed, differences in resources cannot explain the differences in exposure and vulnerability among regions (Nicholls *et al.*, 2008). Governance capacities and the inadequacy of and lack of synergy between institutional and legislative arrangements for disaster risk reduction, climate change adaptation and poverty reduction are also as much a part of the problem as the shortage of resources. Institutional and legal environments and political will are important, as illustrated by the difference in risk management in various regions of the world (Pelling and Holloway, 2006). In many countries disaster risk management and adaptation to climate change measures are overseen by different institutional structures (see Chapter 1, Section 1.1.3). This is explained by the historical evolution of both approaches. Disaster risk management originated from humanitarian assistance efforts, evolving from localized, specific response measures to preventive measures, which seek to address the broader environmental and socio-economic aspects of vulnerability that are responsible for turning a hazard into a disaster in terms of human and/or economic losses. Within countries, disaster risk management efforts are often coordinated by Civil Defence, while measures to adapt to climate change are usually developed by Environment Ministries. Responding to climate change is originally more of a top-down process, where advances in scientific research led to international policy discussions and frameworks. While the different institutional structures may represent an initial coordination challenge, the converging focus on vulnerability reduction represents an opportunity for managing disaster and climate risks more comprehensively within the development context (Sperling and Szekely, 2005). A change in the culture of public administration towards creative partnerships between national and local governments and empowered communities has been found in some cases to dramatically reduce costs (Dodman *et al.*, 2008).

In addition to the barriers described above, there is also a tendency for individuals and groups to focus on the short-run and to ignore low probability high impact events. The following studies discuss some of the psychological and economic barriers shaping how people make decisions under uncertainty:

- *Underestimation of the risk*: Even when individuals are aware of the risks, they often underestimate the likelihood of the event occurring (Smith and McCarty, 2006). This bias can be amplified by natural variability (Pielke *et al.*, 2008), where there is expert disagreement, and where there is uncertainty. Magat *et al.* (1987), Camerer and Kunreuther (1989) and Hogarth and Kunreuther (1995), for example, provide considerable empirical evidence that individuals do not seek information on probabilities in making their decisions.
- *Budget constraints*: If there is a high upfront cost associated with investing in adaptation measures, individuals will often focus on short-run financial goals rather than on the potential long-term benefits in the form of reduced risks (Kunreuther *et al.*, 1978; Thaler, 1999).
- *Difficulties in Making Trade-offs*: Individuals are also not skilled in making trade-offs between costs and benefits of these measures, which requires comparing the upfront costs of the measure with the expected discounted benefits in the form of loss reduction over time (Slovic, 1987).

- *Procrastination*: Individuals are observed to defer choosing between ambiguous choices (Tversky and Shafir 1992; Trope and Liberman, 2003).
- *Samaritan's Dilemma*: Anticipated availability of post-disaster support can undermine self-reliance when there are no incentives for risk reduction (Burby *et al.*, 1991).
- *Politician's Dilemma*: Time delays between public investment in risk reduction and benefits when hazards are infrequent, and the political invisibility of successful risk reduction can be pressures for a NIMTOF (Not in My Term of Office) attitude that leads to inaction (Michel-Kerjan, 2008).

Work in West and East Africa has shown that rural communities tend to underestimate external forces that influence their region while overestimating their own response capacity (Enfors *et al.*, 2008; Tschakert *et al.*, 2010). Misjudging external drivers may be explained by the low degree of control people feel they have over these drivers, resulting in reactions that range from powerlessness to denial. Another issue that makes it difficult to reconcile short-term and long-term goals arises from the challenges in projecting the long-term climate and corresponding risks (see Chapter 3.2.3). Examples of this challenge are reflected in the demographic growth of Florida in the 1970s and 1980s, which unfolded during a period of low hurricane activity but may expose larger populations to the risks associated with extreme climate and weather events. Major engineering projects with long lead-times from planning to implementation have difficulty factoring in climate change futures, and have instead been planned according to historic hazard risk (Pielke *et al.*, 2008). Managing natural risks and adapting to climate change requires anticipating how natural hazards will change over the next decades, but uncertainty on climate change and natural variability is a significant obstacle to such anticipation (Reeder *et al.*, 2009).

Climate change is typically viewed as a slow-onset, multigenerational problem. Consequently, individuals, governments and businesses have been slow to invest in adaptation measures. Research in South Asia shows that in those regions where past development had prioritized short-term gains over long-term resilience, agricultural productivity is in decline because of drought and groundwater depletion, rural indebtedness is increasing and households are sliding into poverty with particularly insidious consequences for women, who face the brunt of nutritional deprivation as a result (Moench *et al.*, 2003; Moench and Dixit, 2007). Connecting short- and long-term perspectives is thus seen as critical to realizing the synergies between disaster risk management and climate change adaptation.

### 8.3.3. *Connecting Short- and Long-Term Actions to Promote Resilience*

The previous section has highlighted the importance of linking short-term and long-term responses so that disaster risk reduction and climate change adaptation mutually support each other. A systems approach that emphasizes cross-scale interactions can provide important insights on how to realize synergies between disaster risk management and climate change adaptation. Resilience, a concept fundamentally concerned with how a system, community, or individual can deal with disturbance and surprise, increasingly frames contemporary thinking about sustainable futures in the context of climate change and disasters (Walker and Salt, 2006; Folke, 2006; Brand and Jax, 2007; Bahadur *et al.*, 2010). It has developed as a fusion of ideas from several bodies of literature: ecosystem stability (e.g., Holling, 1973; Gunderson, 2009), engineering robust infrastructures (e.g., Tierney and Bruneau, 2007), the behavioral sciences (Norris, 2011), psychology (e.g., Lee *et al.*, 2009), disaster risk reduction (e.g., Cutter *et al.*, 2008), vulnerabilities to hazards (Moser, 2009) and urban and regional development (e.g., Simmie and Martin, 2010). In the context of this report, resilience refers to a system's capacity to anticipate and reduce, cope with, and respond to and recover from external disruptions (see Chapter 1, Sections 1.1.2.1 and 1.3.2). Resilience perspectives can be used as an approach for understanding the dynamics of human-environmental systems and how they respond to a range of different perturbations (Carpenter *et al.*, 2001; Walker *et al.*, 2004).

'Resilience thinking' (Walker and Salt, 2006) may provide a useful framework to understand the interactions between climate change and other challenges, and in reconciling and evaluating trade-offs between short-term and longer-term goals in devising response strategies. Approaches that focus on resilience emphasize the need to manage for change, to see change as an intrinsic part of any system, social or otherwise, and to 'expect the unexpected'. Resilience thinking goes beyond the conventional engineering systems emphasis on capacity to control and absorb external shocks in systems assumed to be stable (Folke, 2006). For social-ecological systems (examined as a set of interactions

between people and the ecosystems they depend on), resilience involves three properties: the amount of change a system can undergo and retain the same structure and functions; the degree to which it can re-organise, and; the degree to which it can build capacity to learn and adapt (Folke, 2006). Resilience can also be considered a dynamic process linked to human agency, as expressed in the ability to deal with hazards or disturbance, to engage with uncertainty and future changes, to adapt, cope, learn and innovate, and to develop leadership capacity (Bohle *et al.*, 2009; Obrist *et al.*, 2010).

Resilience approaches offer four key contributions for living with extremes: First, in providing a holistic framework to evaluate hazards in coupled social-ecological systems; second, in putting emphasis on the capacities to deal with hazard or disturbance; third, in helping to explore options for dealing with uncertainty and future changes; and fourth, in identifying enabling factors to create proactive responses (Berkes, 2007; Obrist *et al.*, 2010). The concept of resilience is already being applied as a guiding principle to disaster risk reduction and adaptation issues, as well as to examine specific responses to climate change in different developed and developing country contexts (e.g., Cutter *et al.*, 2008). Eakin and Webbe (2008) use a resilience framework to show the interplay between individual and collective adaptation can be related to wider system sustainability. Goldstein (2009) uses resilience concepts to strengthen communicative planning approaches to dealing with surprise. Linnenluecke and Griffiths (2010) use a resilience framework to explore organizational adaptation to climate change and weather extremes, and suggest that organizations may need to develop multiple capabilities and response approaches in response to changing extremes. Nelson *et al.* (2007) have shown how resilience thinking can enhance analyses of adaptation to climate change: As adaptive actions affect not only the intended beneficiaries but have repercussions for other regions and times, adaptation is part of a path-dependent trajectory of change. Resilience also considers a distinction between incremental adjustments and system transformation, which may broaden the expanse of adaptation and also provide space for agency (Nelson *et al.*, 2007). Resilience approaches can be seen as complementary to agent-based analyses of climate change responses that emphasize processes of negotiation and decision-making, as they can provide insights into the systems-wide implications. Adger *et al.* (2011) show that dealing with specific risks without taking into account the nature of system resilience can lead to responses that potentially undermine long-term resilience.

Recent work on resilience and governance has focused on the communication of science between actors and depth of inclusiveness in decision-making as key determinants of the character of resilience. In support of these approaches it is argued that inclusive governance facilitates better flexibility and provides additional benefit from the decentralisation of power. On the down side, greater participation can lead to loose institutional arrangements that may be captured and distorted by existing vested interests (Adger *et al.*, 2005; Plummer and Armitage, 2007). Still, the balance of argument (and existing centrality of institutional arrangements) call for a greater emphasis to be placed on the inclusion of local and lay voices and of diverse stakeholders in shaping agendas for resilience through adaptation and adaptive management (Nelson *et al.*, 2007). Striking the right balance between top-down command-and-control approaches, which offers stability over the short term, but reduced long-term resilience, and more flexible, adaptive forms of risk management is the core practical challenge that disaster risk management brings to climate change adaptation under conditions of climatic extremes and projected increases in disaster risk and impact (Sperling and Szekely, 2005).

Resilience thinking is not without its critiques (Nelson, 2009; Pelling, 2010a). Shortcomings include the downplaying of human agency in systems approaches and difficulty in including analysis of power in explanations of change, which combine to effectively promote stability rather than flexibility, i.e., maintaining the *status quo* and thus serving particular interests rather than supporting adaptive management, social learning or inclusive decision-making. One challenge to enhancing resilience of desired system states is to identify how responses to any single stressor influence the larger, interconnected social-ecological system, including the system's ability to absorb perturbations or shocks, its ability to adapt to current and future changes, and its ability to learn and create new types or directions of change. Responses to one stressor alone may inadvertently undermine the capacity to address other stressors, both in the present and future. For example, coastal towns in eastern England, experiencing worsening coastal erosion exacerbated by sea level rise, are taking their own action protect against immediate erosion in order to protect livelihoods and homes, affecting sediments and erosion rates down the coast (Milligan *et al.*, 2009). While such actions to protect the coast are effective in the short-term, in the long-term investing to 'hold-the-line' may diminish capital resources for other adaptations and hence reduced adaptive capacity to future sea level rise. Thus dealing with specific risks without a full accounting of the nature of system resilience can lead to responses that can

potentially undermine long-term resilience. Despite an increasing emphasis on managing for resilience (Walker *et al.*, 2002; Lebel *et al.*, 2006), the resilience lens alone may not sufficiently illuminate how to enhance agency and move from the understanding of complex dynamics to transformational action.

#### **8.4. Implications for Access to Resources, Equity, and Sustainable Development**

The previous section assessed the interlinkages between adaptation, disaster risk management and mitigation objectives. This section takes the idea of interlinkages further. It explores the relationships between climate change adaptation, disaster risk management and mitigation, and larger issues related to equity, access to resources, environmental and ecosystem protection and related development processes. This draws out the importance of governance in determining the relationship between disaster risk and underlying processes of unequal socio-economic development and environmental injustices (Maskrey, 1994; Sacoby *et al.*, 2010). The section discusses issues related to capacity and equity, the existence of winners and losers from disaster and disaster management policy, and opportunities for contributing to wider development goals including the enhancing of human security.

##### **8.4.1. Capacities and Resources: Availability and Limitations**

The capacity to manage risks and adapt to change is unevenly distributed within and across nations, regions, communities and households (Hewitt, 1983, Wisner *et al.*, 2004; Beck, 2007). The literature on how these capacities contribute to disaster risk management and climate change adaptation emphasizes the role of economic, financial, social, cultural, human, and natural capital, and of institutional context (see Chapter 1, Section 1.4; Chapter 2, Section 2.4). When the poor are impacted by disasters limited resources are quickly expended in coping actions that can further undermine household sustainability in the long-run, reducing capitals and increasing hazard exposure or vulnerability. In these vicious cycles of decline households tend first to expend savings and then, if pressures continue, to withdraw members from non-productive activities such as school, and finally sell productive assets. As households begin to collapse individuals may be forced to migrate or in some cases enter into culturally inappropriate, dangerous or illegal livelihoods such as the sex industry (Mgbako and Smith, 2010, Ferris, 2011). This poverty and vulnerability trap means that recovery to pre-disaster levels of wellbeing becomes increasingly difficult (Chambers, 1989; Burton *et al.*, 1993; Adger, 1996, Wisner *et al.*, 2004).

Children, the elderly and women stand out as more vulnerable to extreme climate and weather events. The vulnerability of children and their capacity to respond to climate change and disasters is discussed in Box 8-2 (see also Chapter 5, Section 5.5.1 and Chapter 9, Section 9.2.14). Amongst the elderly, increasing numbers will become exposed to climate change impacts in the coming decades, particularly in OECD countries where populations are aging most rapidly. By 2050, it is estimated that one in three people will be above 60 years in OECD countries, as well as 1 in 5 at the global scale (UN, 2002). The elderly are made additionally vulnerable to climate change related hazards by characteristics that also increase vulnerability to other social and environmental hazards (thus compounding overall vulnerability): deterioration of health, personal lifestyles, social isolation, poverty, and inadequate access to health and social infrastructures (OECD, 2006). Gender impacts vulnerability in many ways. In the 1991 cyclone in Bangladesh, the death toll amongst women was reportedly five times higher than among men (UNDP, 2007b). Cultural as well as physiological factors are widely cited for the over-representation of female deaths from flooding. Gender inequality extends into female headed households to compound the vulnerability of dependent children or elderly (Cannon, 2002; ISDR, 2008; Oxfam, 2010). Inequality has many other important faces; race, cast, religious affiliation and physical disability: all help determine individual and household vulnerability, and they cross-cut gender and age effects. Importantly, the social construction of vulnerability through these characteristics highlights the ways in which the production of vulnerability changes over time – in this case with changes in family structure and access to services in response to economic cycles, political and cultural trends evolving as the climate changes with potentially compounding effects (Leichencko and O'Brien, 2008).

\_\_\_\_\_ START BOX 8-2 HERE \_\_\_\_\_

## Box 8-2. Children, Extremes, and Equity in a Changing Climate

The linkages between children and extreme events have been addressed through two principle lenses:

### *1. Differentiated Impacts and Vulnerability*

The literature estimates that 66.5 million children are affected annually by disasters (Penrose and Takaki, 2006). Research on disaster impacts amongst children focuses on short- and long-term physical and psychological health impacts (Bunyavanich *et al.*, 2003; Balaban, 2006; Bartlett, 2008; del Ninno and Lindberg, 2005; Norris *et al.*, 2002; Waterson, 2006). Vulnerability to these impacts in part is due to the less developed physical and mental state of children, and therefore differential capacities to cope with deprivation and stress in times of disaster (Bartlett, 2008; Cutter, 1995; Peek, 2008).

Most literature points towards higher mortality and morbidity rates among children for climate stresses and extreme events (Cutter, 1995; Bunyavanich *et al.*, 2003; Telford *et al.*, 2006; Waterson, 2006; Bartlett, 2008; Costello *et al.*, 2009; Sánchez *et al.*, 2010). This is especially acute in developing countries, where climate-sensitive health outcomes such as malnutrition, diarrhoea and malaria are already common and coping capacities are lowest (Haines *et al.*, 2006), although research in the USA found relatively low child mortality from disasters and considerable differences across age groups for different types of hazard (Zahran *et al.*, 2008).

Recent studies conducted in Bolivia, Indonesia, Mexico, Mozambique, Nepal, the Philippines and Vietnam provide evidence of how extensive (low impact/high frequent) disasters negatively affect children's education, health and access to services such as water and sanitation, an issue of critical importance given the importance of primary education for human and long-term economic development. In areas in Bolivia that experienced the greatest incidence of extensive disasters, the gender gap in primary education achievement widened, pre-school enrolment rates decreased and dropout rates increased. Equivalent areas in Nepal and Vietnam saw, respectively, reduced primary enrolment rates and a drop in the total number of children in primary education. Extensive disasters also led to an increased incidence of diarrhoea in children under five years of age in Bolivia, an increased proportion of malnourished children under three in Nepal, an increased infant mortality rate in Vietnam, and an increase in the incidence of babies born with low birth weight in Mozambique. This study also found evidence of negative impacts in terms of access to water and sanitation in Mexico and Vietnam. (ISDR, 2011).

These studies underpin the need for resources for child protection during and after disaster events (Last, 1994; Jabry, 2003; Bartlett, 2008; Lauten and Lietz, 2008; Weissbecker *et al.*, 2008). These include protection from abuse, especially during displacement, social safety nets to guard against withdrawal from school due to domestic or livelihood duties, and dealing with psychological and physical health issues (Norris *et al.*, 2002; Evans and Oehler-Stinnett, 2006; Bartlett, 2008; Lauten and Lietz, 2008; Keenan *et al.*, 2004; Peek, 2008; Waterson, 2006; Davies *et al.*, 2008).

### *2. Children's Agency and Resource Access*

Rather than just vulnerable victims requiring protection, children also have a critical role to play in tackling extreme events in the context of climate change (Tanner, 2010). There is also increasing attention to child-centred approaches to preventing, preparing for, coping with, and adapting to extreme events (Peek, 2008; Tanner, 2010).

While often centred on disaster preparedness and climate change programmes in education and schools (Wisner, 2006; Bangay and Blum, 2010), more recent work emphasises the latent capacity of children to participate directly in disaster risk reduction or adaptation supported through child-centred programmes (Back *et al.*, 2009; Tanner *et al.*, 2009). This emphasis acknowledges the unique risk perceptions and risk communication processes of children, and their capacity to act as agents of change before, during *and* after disaster events (see collections of case studies in Peek, 2008; Back *et al.*, 2009; and Tanner, 2010). Examples demonstrate the ability to reduce risk behaviour at

households and community scale, but also to mobilise adults and external policy actors to change wider determinants of risk and vulnerability (Tanner *et al.*, 2009; Mitchell *et al.*, 2008).

\_\_\_\_\_ END BOX 8-2 HERE \_\_\_\_\_

Studies also show that female-headed households more often borrow food and cash than rich and male-headed households during difficult times. This coping strategy is considered to be a dangerous one as the households concerned will have to return the food or cash soon after harvests, leaving them more vulnerable as they have less food or cash to last them the season and to be prepared if disaster strikes (Young and Jaspars, 1995). This may leave households in a cycle of poverty from one season to the next. Literature shows that this outcome is linked to unequal access to resources, land, public and privately provided services by women (Agarwal, 1991; Nemarundwe, 2003; Njuki *et al.*, 2008; Thomas-Slayter *et al.*, 1995). But women are also often the majority holders of social capital and the mainstay of social movements and local collective action, providing important mechanisms for household and local risk reduction and potentially transformative resilience. Important here are local saving groups and microcredit/micro-finance groups, some of which extend to micro-insurance. In a review of microfinance for disaster risk reduction and response in South Asia, Chakrabarti and Bhatt (2006) identify numerous initiatives, including those that build on extensive social networks and connect to the formal financial services sector.

Demographic and sociological diversity is also difficult to capture in decision making where non-scientific knowledge is less easily incorporated into formal decision-making. The importance of culture, including traditional knowledge, in shaping strategies for adaptation is recognised (Heyd and Brooks, 2009; ISET, 2010). There is a long tradition of seeking to identify and bring such knowledges into planned disaster risk management in urban and rural contexts through participatory and community based disaster risk management (Pelling, 2007; Mercer *et al.*, 2008; Bruner *et al.*, 2001; Fearnside, 2001; Miles *et al.*, 2004) and tools such as participatory GIS that explicitly seek to bring scientific and local knowledge together (Tran *et al.*, 2009). Both development planning and post-disaster recovery have tended to prioritise strategic economic sectors and infrastructure over local livelihoods and poor communities (Maskrey, 1989; 1996). However, this represents a missed opportunity for building local capacity and including local visions for the future in planning the transition from reconstruction to development--opportunities that could increase long-term sustainability (Christoplos, 2006).

#### **8.4.2. Local, National, and International Winners and Losers**

While climate-related hazards cannot always be prevented, the scale of loss and its social and geographical distribution do differ significantly, determined by the characteristics of those at risk and overarching structures of governance including the legacy of preceding development paths on social institutions, economy and physical assets (Oliver-Smith, 1994). But some people also benefit from disasters. These may be organisations or individuals who benefit economically from reconstruction or response (West and Lenze, 1994; Hallegatte, 2008b), through the supplying materials, equipment, and services – often at a premium price generated by local scarcity and inflationary pressures (Benson and Clay, 2004), or as a result of poorly managed tendering processes (Klein, 2007). Areas not impacted by disaster can also experience economic benefits, for example in the Caribbean where hurricanes have caused international tourist flows to be redirected (Pelling and Uitto, 2001). Political actors can also benefit by demonstrating strong post-disaster leadership, at times even when past political decisions have contributed to generating disaster risk (Olson and Gawronski, 2003; Le Billon and Waizenegger, 2007; Gaillard *et al.*, 2008). The same can be said for climate change, with very unequal consequences in various regions of the world and various economic sectors and social categories (Adger *et al.*, 2003; O'Brien *et al.*, 2004; Tol *et al.*, 2004). Less directly, those who have benefitted from policies and processes, such as expansion of commercial agriculture or logging, can also be described as benefiting from decisions that have generated vulnerability and prefigured disaster for others. Such costs and benefits are often separated geographically and temporally, making any efforts at distributional equity challenging. For example, in the case of Hurricane Mitch, which killed more than 10,000 people and caused as much as \$8.5 billion in damages, deforestation and rapid urban growth are often cited among the key causes of the disaster related losses (Alves, 2002; Pielke *et al.*, 2003) with those benefiting from such development including distant speculators.

Analyses of winners and losers associated with climate change and discrete hazards need differentiation. In almost every circumstance, what one part of society views as a win can be viewed by another part as a loss. In examining possible responses to risks of climate extremes it is essential to recognize that possible impacts interact with vested interests of different locations, sectors, and population groups in very different ways. In virtually every case, the question is: benefits for whom? Who says that this course of action is best for society as a whole? What compensation is offered for those who are losers? In particular, who is listening to views of those parts of society that have less political power and influence?

While individual events can be assessed as a snapshot of winners and losers, climate change as an ongoing process has no final state. Over time, it may produce different distributions of winners and losers, for example as areas experience positive and then negative consequences of changes in temperature or precipitation. Whether or not a particular place produces winners or losers from an extreme event or a combination of climate extremes and other driving forces also depends on perceptions. These may be shaped by the recovery process, but are strongly influenced by prioritized values (Quarentelli, 1984; 1995; O'Brien, 2009; O'Brien and Wolf, 2010). In considering winners and losers from extreme climate and weather events, and also from the outcomes of policies directed at reducing disaster risk or responding to climate change, it is thus vital to recognize the subjective understanding of winners and losers.

Much depends upon an individual, group or society's dominant values, perspectives and access to information. While some regard winners and losers as a natural and inevitable outcome of ecological changes and/or economic development, others suggest that winners and losers are deliberately generated by unequal political and social conditions (Wisner 2003, O'Brien and Leichenko, 2003). Lurking behind discourses about winners and losers are issues of liability and compensation for losses: i.e., if a population or an area experiences severe losses due to an extreme event (at least partly) attributed to climate change, can fault be prescribed? Does responsibility lie with those who have generated local environmental change through settling a hazard exposed area, those who have promoted or permitted such settlement, or those who have failed to mitigate local hazard or global environmental change? Issues of equity, justice, and compensation are emerging in climate change adaptation, but few have begun to deal with questions of liability for disaster risk production beyond the local scale (Kent, 2001; Wisner, 2001; Mitchell, 2001; O'Brien *et al.*, 2010b). It seems that efforts to assign responsibility will emerge as an issue for both governments and courts at a range of scales (Farber, 2007).

#### **8.4.3. *Potential Implications for Human Security***

Changes in extreme climate and weather events threaten human security, and both disaster risk management and climate change adaptation represent strategies that can improve human security while also avoiding disasters. Human security addresses the combined but related challenges of upholding human rights, meeting basic human needs, and reducing social and environmental vulnerability (UNDP, 1994; Brauch, 2009; Fuentes and Brauch 2009; Sen, 2003; Bogardi and Brauch, 2005; Brauch 2005a, 2005b). It also emphasizes equity, ethics, and reflexivity in decision-making and a critical questioning and contestation of the drivers of climate change (O'Brien *et al.*, 2010b) and local impacts (Pelling, 2010a). Human security is realized through the capacity of individuals and communities to respond to threats to their environmental, social, and human rights (GECHS, 2000; Barnett *et al.*, 2010). A number of studies have assessed the relationship between climate change and human security, demonstrating that the linkages are often both complex and context-dependent (Barnett, 2003; Barnett and Adger, 2007; Buhaug *et al.*, 2008; O'Brien *et al.*, 2010a; Brauch *et al.*, 2008; 2009; 2011). Among the most likely human security threats are impacts felt through damage to health, food, water or soil conditions (Oswald Spring, 2009a; Oswald Spring *et al.*, 2011b).

Among the most widely-discussed humanitarian and human security issues related to climate change are the possibilities of increased migration and/or violent conflict resulting from the biophysical or ecological disruptions associated with climate change (Reuveny, 2007; K. O'Brien *et al.*, 2008; Raleigh *et al.*, 2008; Warner *et al.*, 2010). There are indications that migration conditions followed disasters in the distant past, as well as in current situations (see, e.g., Le Roy Ladurie, 1971; Kinzig *et al.*, 2006; Peebles *et al.*, 2006). Migration is a key coping mechanism for poor rural households, not only in extreme circumstance (e.g., during a prolonged drought, as with the 20<sup>th</sup> Century

U.S. Dustbowl period and Sahelian droughts) but also as a means of diversifying and increasing income (Harrington *et al.*, 2009; Oswald Spring, 2011a ; Scheffran, 2011). The opportunities that population movement opens for risk reduction are seen in international remittance flows from richer to poorer countries. These are estimated to have exceeded US\$318 billion in 2007, of which developing countries received US\$240 billion (World Bank, 2008).

Disasters linked to extreme events often lead to forced displacement of people, as well as provoking voluntary migration amongst the less poor. The relationship between climate risk and displacement is a complex one and there are numerous factors that affect migration (UNDP, 2009). Nonetheless, recent research suggests that adverse environmental impacts associated with climate change have the potential to trigger displacement of an increased number of people (Kolmannskog, 2008; Feng *et al.*, 2010). Studies suggest that most migration will take place internally within individual countries; that in most cases when climatic extremes occur in developing countries they will not lead to net out-migration because people tend to return to re-establish their lives after a disaster; and that while long-term environmental changes may cause more permanent migration this will also tend to be internal (Piguet, 2008; UNDP, 2009). More negatively, forced land abandonment is stressful for migrants whose culture and sense of identity are affected (Mortreux and Barnett, 2008; Sánchez *et al.*, 2011; Brauch and Oswald Spring, 2011). The social dislocation provoked by migration can lead to a breakdown in traditional rural institutions and associated coping mechanisms, for example, in the erosion of traditional community based water management committees in central and west Asia (Birkenholtz, 2008). Local collective coping and adaptive capacity can also be limited by increases in the number of female-headed households as men migrate (Oswald Spring, 1991; 2009a).

Attention has been mainly focused on population displacement associated with large disasters. Pakistan's 2010 floods have to date left an estimated 6 million people in need of shelter; India's 2008 floods also uprooted roughly 6 million people; Hurricane Katrina displaced more than half a million people in the United States of America; and Cyclone Nargis uprooted 800,000 people in Myanmar and South Asia. However, the compound effect of smaller, more frequent events can also contribute to displacement. Hazards such as floods, although often causing relatively low mortality, destroy many houses and hence cause considerable displacement. Between 1970 and 2009 in Colombia, for example, 24 disaster loss reports detailed floods that killed fewer than 10 people but destroyed more than 500 houses. In total, around 26,500 houses were destroyed, potentially displacing more than 130,000 people. In the Indian state of Orissa, 265 floods with similar low mortality rates destroyed more than half a million houses. It is estimated that such extensive disasters account for an additional 19% displacement, people who are typically less visible than those displaced in larger events that attract international media and humanitarian assistance (ISDR, 2011).

Despite the opportunities to enhance development, disaster response is often better at meeting basic needs than securing or extending human rights. Indeed, the political neutrality that underpins the humanitarian imperative makes any overt actions to promote human rights by humanitarian actors difficult. In this way disaster response and reconstruction can to only a partial extent claim to enhance human security (Pelling and Dill, 2009). Work at the boundaries between humanitarian and development actors, new partnerships, the involvement of government and meaningful local participation are all emerging as ways to resolve this challenge. One successful case has been the reconstruction process in Aceh, Indonesia following the India Ocean Tsunami, where collaboration between government and local political interests, facilitated by international humanitarian actions on the ground and through political level peace building efforts have increased political rights locally, contained armed conflict and provided an economic recovery plan (le Billon and Waizenegger, 2007; Gaillard *et al.*, 2008; Törnquist *et al.*, 2010).

Coping with the new and unprecedented threats to human security posed by climate change has raised questions about whether existing geopolitics and geostrategies have become obsolete (Dalby, 2009). The concepts, strategies, policies and measures of the geopolitical and strategic toolkits of the past as well as the short-term interests dominating responses to climate change have been increasingly questioned, while the potential for unprecedented disasters has led to a consideration of the security implications of climate change (UNSC, 2007; EU, 2008; UNGA, 2009; UNSG, 2009). Concerns range from increased needs for humanitarian assistance to concerns over environmental migration, emergent diseases for humans or in food chains, potentials for conflict between nations or localities over resources, and potential for political/governmental destabilization due to climate-related stresses in combination with other stresses, along with efforts to assign blame (Ahmed 2009; Brauch and Oswald Spring, 2011).



Climate change is generally regarded to act as a threat multiplier for instability in some of the most volatile regions of the world (CNA Corporation, 2007). Even in stable polities adaptation planning that seeks long-term resilience is confronted by political instability directly after disasters (Drury and Olson, 1998; Olson, 2000; Pelling and Dill, 2009; UNDP, 2004). When disasters strike across national boundaries or within areas of conflict, they can provide a space for rapprochement, but effects are usually short lived unless the underlying political and social conditions are addressed (Kelman, 2003; Kelman and Koukis, 2000). New interest in disaster and climate change as a security concern has brought in lessons from international law (Ammer *et al.*, 2010) and security policy (Campbell *et al.*, 2007) on planning for relatively low-probability/high-consequence futures. Although during times of stress, it is easy for polities to drift towards militarization and authoritarianism for managing disaster risk (Albala-Bertrand, 1993), there are alternatives, such as inclusive governance, which can meet the goals of sustainable development and human security over the long-term (Brauch, 2009; Bauer, 2011 Olson and Gawronski, 2003; Pelling and Dill, 2009).

#### **8.4.4. Implications for Achieving Relevant International Goals**

Addressing—or failing to address— disaster risk reduction and climate change adaptation can influence the success of international goals, particularly those linked to development. Successive reports have noted the potential for climate change to derail the MDGs. In 2003, the Asian Development Bank (ADB) and nine other development organizations first highlighted that climate change may impact on progress towards the Millennium Development Goals (MDGs) and in particular constrain progress beyond 2015, underlying the importance of managing climate risks within and across development sectors. The UK Department for International Development (DFID) (2004, 2006) and UNDP (2004) show how each of the Millennium Development Goals is dependent on some aspect of disaster risk for success. Disaster impacts on the MDG targets are both direct and indirect. For example, MDG 1 (to eradicate extreme poverty and hunger) is impacted directly by damage to productive and reproductive assets of the poor and less poor (who may remain in poverty or slip into poverty as a result of disaster loss), and indirectly effected by negative macroeconomic impacts. The *2007 UN Human Development Report* noted that enhanced adaptation is required to protect the poor with climate change potentially acting as a break on development beyond 2015.

The UN-ISDR *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* (HFA) explicitly recognizes climate variability and change are important contributors to disaster risk and includes strong support for better linking disaster management and climate change adaptation efforts (Sperling and Szekely, 2005; see also Chapter 7, Section 7.3.1). The HFA priorities for action have proven foresightful in including resilience explicitly as a component. Priority Three calls for ‘Knowledge, innovation and education to build a culture of safety and resilience at all levels’. This provides a strong justification for international actors to support investment in institutional and human capacity for national and local resilience building, and one that does not require the addition of new international agreements to start work. Frameworks for such action exist for example in Common Country Assessments, United Nations Development Assistance Frameworks, National Adaptation Plans of Action, and Poverty Reduction Strategies, but limited progress has been made on this to date (DFID, 2004). Some have proposed integrating climate change and disaster risk management into any equivalent of the Millennium Development Goals post-2015 (Tribe and Lafon, 2009; Gostin *et al.*, 2011).

### **8.5. Interactions among Disaster Risk Management, Adaptation to Climate Change Extremes, and Mitigation of Greenhouse Gas Emissions**

#### **8.5.1. Thresholds and Tipping Points as Limits to Resilience**

Recent literature suggests that climate change could trigger large-scale, system-level regime shifts that could significantly alter climatic and socio-economic conditions (MA, 2005; Lenton *et al.*, 2008; Hallegatte *et al.*, 2010; see Chapter 3, Section 3.1.7). Examples of potential system changes include dieback of the Amazon rainforest, decay of the Greenland ice sheet, and changes in the Indian summer monsoon (Lenton *et al.*, 2008). At smaller scales too climate change is exacerbating well-established examples of environmental regime shifts, such as

freshwater eutrophication (Carpenter, 2003), shifts to algae-dominated coral reefs (Hughes *et al.*, 2003), and woody encroachment of savannas (Midgley and Bond, 2001). The abruptness and persistence of such changes in social and ecological systems, coupled with the fact that they can be difficult and sometimes impossible to reverse, means that they can have substantial impacts on human well-being (Scheffer *et al.*, 2001; MA, 2005; Scheffer, 2009). The notion of regimes shifting once thresholds or tipping points are crossed contrasts with discussions of climate thresholds (see Chapter 3, Section 3.1.1), and traditional thinking about gradual, linear and more predictable changes in ecological and social-ecological systems and emphasizes the possibility of multiple futures determined by the crossing of critical thresholds (Gunderson and Holling, 2002; Levin, 1998). Similar discussion in socio-economic systems has, for example, identified profitability limits in economic activities as critical thresholds which can bring about sudden collapse and regime change (e.g., Schlenker and Roberts, 2006; OECD, 2007).

The metaphor of tipping points, or points at which a system shifts from one state to another, can also be applied to disaster events. Disasters themselves are threshold-breaching events, where coping capacities of communities are overwhelmed (e.g. Blaikie *et al.*, 1994; Sperling *et al.*, 2008). Disasters may lead to secondary hazards, e.g., when the impacts from one disaster breach the coping capacities of related systems, as when hurricane impacts trigger landslides or when different disasters produce concatenated impacts over time (Biggs *et al.*, 2011). For example, losses associated with droughts and fires during the 1997/1998 ENSO event in Central America increased landslide and flood hazard during Hurricane Mitch in 1998 (Villagrán, 2011). Critical social thresholds may be crossed as disaster impacts spread across society. Disaster response is as much about containing such losses as assisting those hurt by the initial disaster impact.

For the poor, life and health are immediately at risk; for those living in societies that take measures to protect infrastructure and economic and physical assets, the lives and health of the population are less at risk. However, a threshold can be crossed when hazards exceed anticipated limits, are novel or unexpected in a specific risk management domain (Beniston, 2004; Schär *et al.*, 2004; Salagnac, 2007), or when vulnerability has increased or resilience decreased due to spill-over from market and other shocks (Wisner, 2003). In 2010, for example, western Russia experienced the hottest summer since the beginning of systematic weather data recording 130 years ago. Lack of rainfall in early 2010 and July temperatures almost 8°C above the long-term average, led to parched fields, forests and peat lands that posed a high wildfire risk. During and after the wildfires, Russia's mortality rate increased by 18 percent. In August alone, 41,300 more people died as compared to August 2009, due to both the extreme heat and smoke pollution. Social and economic change had greatly increased the risk posed by wildfires. Traditional agricultural livelihoods have declined, accompanied by out-migration and reduced management of surrounding forests, arguably exacerbated by the decentralization of national management and increased exploitation by the private sector (ISDR, 2011).

The recognition of non-linearity and the importance of thresholds as limiting points for existing systems has led climate scientists to increase their attention to the “tails” of impact probability density functions (Weitzman, 2009). This is in contrast to the disasters research community which, after focusing on major extremes, is now recognizing the importance of small or local disasters, and in the secondary disasters that make up concatenated events (UNDP, 2004; ISDR, 2009). Both lenses are valuable for a comprehensive understanding of the interaction of disaster impact with development.

Tipping points in natural and human systems are more likely to arise with relatively severe and/or rapid climate change than with moderate levels and rates (Wilbanks *et al.*, 2007). Because of this, less success with climate change mitigation implies greater challenges for adaptation and disaster risk management. Not only does adaptation need to consider incremental change in hazard and vulnerability, but the possibility of threshold breaching, systems-wide changes. The non-linear changes associated with breaching thresholds may exceed adaptation capacity to avoid serious disruptions. Examples of ecological systems changes of this kind and social impacts include the disappearance of glaciers currently feeding urban and agricultural water supply (Orlove, 2009), effects of climate change on traditional livelihoods for the sustainability of indigenous cultures (Turner and Clifton, 2009), widespread loss of corals in acidifying oceans and fisher livelihoods (Reaser *et al.*, 2000), and profitability limits for important economic activities like agriculture, fisheries and tourism. When socio-economic systems are already under stress (e.g., fisheries in many countries), sustainability thresholds may be more easily passed. Responses to potential thresholds or tipping points include efforts to improve the information available to decision-makers, for example

through monitoring systems to provide early warning of an impending system collapse (Scheffer *et al.*, 2009; Biggs *et al.*, 2009), but also initiatives researching the balance of risks associated with geo-engineering (Royal Society, 2009) aiming to avoid such climate points (Kiehl, 2006; Virgoe, 2002).

### 8.5.2. *Adaptation, Mitigation, and Disaster Risk Management Interactions*

As indicated above, the extent to which future adaptation and disaster risk reduction action will be required is likely to be dependent on the extent and rapidity with which climate change mitigation actions may be taken and resulting risk unfolds for any given development context. This section assesses the ways in which mitigation, disaster risk reduction and adaptation interact with development in urban and rural contexts.

In many instances, climate change mitigation and adaptation may be synergistic, such as land-use planning to reduce transport-related energy consumption and limit exposure to floods, or building codes to reduce heating energy consumption and enhance robustness to heat waves (McEvoy *et al.*, 2006). There is an emerging literature exploring the linkages between climate change mitigation and adaptation, and the possibility of approaches that address both objectives simultaneously (Wilbanks and Sathaye, 2007; Hallegatte, 2009; Wilbanks, 2010; Bizikova *et al.*, 2010; Yohe and Leichenko, 2010). In this section we enlarge the scope of the interactions to include disaster risk management. This builds on experience within the disaster management community that has recently sought to integrate risk modelling (UNDP, 2004; ISDR, 2009; 2011) and planning to consider multi-hazard contexts. An important lesson from this is that avoiding superficial integration means seeking out and addressing shared root causes of vulnerability to hazards, and not just addressing the surface expressions of risk (Wisner, 2011). The extent of adaptation required will depend on the climate change mitigation efforts undertaken, and it is possible that these requirements could increase drastically if levels of climate change exceed systemic thresholds; whether in geophysical or socio-economic systems.

Practical integration of climate change mitigation and adaption into a development context is complicated because of a differential distribution in costs and benefits (e.g., mitigation benefits are distributed and accrue globally, adaptation benefits, like disaster risk management, are often easier to measure locally). In addition, the research and policy discourses of these three policy domains are quite separated and in areas technically unrelated, and the constituencies and decision-makers are often different (Wilbanks *et al.*, 2007). In many cases, the challenge of bringing the entire range of issues and options into focus – seeking synergies and avoiding conflicts – is most likely to occur in discussions of climate change responses and development objectives in particular places: localities and small regions where compliance with national or international mitigation agendas provides a logic for local action (Wilbanks, 2003). Below, we present the urban and rural contexts as examples.

#### 8.5.2.1. *Urban*

In an increasingly urbanised world, global sustainability in the context of a changing climate will depend on achieving sustainable and climate resilient cities. Urban spatial form is critical for energy consumption and emission patterns and disaster risk management (Desplat *et al.*, 2009), for influencing where and how residents live and the modes of transport that they use. Urban planning is a tool that can be used to pursue climate change mitigation, adaptation and disaster risk reduction as part of the everyday development process (Newman and Kenworthy 1989; Bento *et al.*, 2005; Handy *et al.*, 2005; Ewing and Rong, 2008; Glaeser and Kahn, 2010; Grazi *et al.*, 2008; Brownstone and Golob, 2009). Urban form also influences the spatial and social inequalities that largely shape vulnerability, coping and adaptive capacity (Gusdorf *et al.*, 2008; Leichenko and Solecki 2008, Pelling 2003). The historical failure of urban planning in most developing country cities has had tremendous environmental and social consequences (UN-HABITAT, 2009; World Bank, 2010a). Also in richer countries, where planning is not comprehensive, maladaptation can take place rather than synergistic risk reduction, for example where urban heatwave risk management results in increased private airconditioning without de-carbonised energy available (Lindley *et al.* 2006). Similarly, a denser city may reduce greenhouse gas emission but increase heat wave vulnerability (Hamin and Gurrán, 2009). However, since urban forms influence both greenhouse gas emissions and vulnerability (McEvoy *et al.*, 2006), scope for synergistic planning and action can also be found. For example,

managing car use may contribute to decreased greenhouse gas emissions, but also lower local particulate pollution and reduce the health impacts of urban heat waves (Dennekamp and Carey, 2010).

As yet there is only limited evidence that opportunities for synergistic planning offered by urbanization are being realized, especially by those most marginalized and vulnerable. More typically, urbanization compounds environmental problems. As countries urbanise, the risks associated with economic asset loss tend to increase through rapid growth in infrastructure, productive and social assets, while mortality risk tends to decrease (Birkmann, 2006). As cities grow they also modify the surrounding rural environment, and consequently may generate a significant proportion of the hazard to which they are also exposed. For example, as areas of hinterland are paved over, run-off increases during storms, greatly magnifying flood hazards (Mitchell, 1999; Pelling, 1999). As mangroves are destroyed in coastal cities, storm-surge hazard can increase (Hardoy et al, 2001). As mangroves are destroyed in coastal cities, storm-surge hazard increase. Likewise, within urban areas (though often beyond the reach of urban planning) the expansion of informal settlements can lead to increased local population exposure to landslide and flood hazards (Satterthwaite, 1997; UNDP, 2004). Global risk models indicate that expansion of urban risk is primarily due to rapidly increasing exposure, which outpaces improvements in capacity to reduce vulnerability (such as through improvements legislating and applying building standards and land-use planning), at least in rapidly growing low and middle income nations (ISDR, 2009; ISDR, 2011). As a consequence, risk is becoming increasingly urbanised (Mitchell, 1999; Pelling, 2003a; Leichenko and O'Brien, 2008). There are dramatic differences, nonetheless, between developed and developing countries. In most developed countries (and increasingly in a number of cities in middle-income countries e.g., Bogota, Mexico, City), risk reducing capacities exist which can manage increases in exposure. In contrast, in much of the developing world (and particularly in the poorest LDCs where large proportions of the urban population live in unplanned settlements) such capacities are greatly restricted, while population growth drives exposure. Financial and technical constraints matter for risk management, but differences in wealth alone do not explain differences in risk reduction investments, which also depend on risk perceptions and political choice (e.g., Satterthwaite, 1998; Hardoy et al., 2001; Hanson *et al.*, 2011).

Urban planning can be a vehicle for synergy, but it takes time to produce significant effects. Synergy in planning requires anticipation of future climate change, taking into account how climate will change over many decades, the uncertainty of this information, the vulnerability of urban systems and the capacity of social agents. The Asian Cities Climate Change Resilience Network found that catalyzing city level actors to assess these plans are essential, rather than depending on external experts or national agencies to prepare urban plans (Tyler et al., 2010). Built forms are difficult to change because they exhibit strong inertia and irreversibility: when a low-density city is created, transforming it into a high density city is a long, expensive, and difficult process (Gusdorf *et al.*, 2008). This point is crucial in the world's most rapidly-growing cities, where urban forms of the future are being decided based on actions taken in the present, and where current trends indicate that low-density, automobile dependent forms of suburban settlement are rapidly expanding (Solecki and Leichenko, 2006). Recent work has started to investigate these aspects of climate change adaptation and mitigation (Newman *et al.*, 1996). At the same time, there are specific opportunities when cities enter periods of large scale transformation. This is happening in Delhi, Mumbai and other cities in India as private capital redevelops low-income city neighbourhoods into commercial districts and middle- and high-income housing areas with associated low-income housing. There is rare scope here to promote disaster risk reduction, climate change adaptation and mitigation alongside existing demands for market profitability and social justice into urban and building design. There are also a growing numbers of large-scale slum/informal settlement upgrading programmes that aim to improve housing and living conditions for low-income households (Boonyabanacha, 2005; Satterthwaite, 2010).

Disaster reconstruction also creates opportunities for synergistic development planning. For example, reconstruction after the 2005 Hurricane Katrina disaster in New Orleans, Louisiana included rebuilding to Green Building Council 'Leadership in Energy and Environmental Design' (LEED) standards (U.S. Green Building Council, 2010). Similarly in May 2007, Greensburg, Kansas, was virtually destroyed by a tornado and LEED standards have been applied (Harrington, 2010). Echoing the trade-offs between speed and sustainability presented in Section 8.2.5, the actions in Greensburg have also slowed rebuilding of the town, leading in this instance to an erosion in community and associated aspects of resilience in the short run, while attempting to create a model 'green' community in the long run.

In short, despite the many opportunities for building synergy into urban development planning and practice examples of success are not plentiful. Lack of synergy is more the norm, to take just one example of urbanization in central Dhaka, Bangladesh. These flood prone areas had until recently been occupied by natural water bodies and drains, vital to the regulation of floods. The Dhaka Metropolitan Development Plan restricts development in many of these areas but despite the Plan infilling continues with both private and public-sector projects. Destruction of retention ponds and drains increases risks of flooding and building in the drained wetlands generates new risks of liquefaction following earthquake (ISDR, 2011).

#### 8.5.2.2. Rural

Rural areas are the primary site for climate change mitigation. Rural areas have considerable experience in disaster risk management and more recently in climate change adaptation (UNDP 2007). Nonetheless, as for urban areas, the evidence base is limited for consciously synergistic development projects and policies that consider climate change mitigation, adaptation and disaster management together. There are, however, several important opportunities where climate change mitigation and adaptation or risk management have shown scope for integration and opportunities are being explored, for example in agroforestry (Verchot *et al.*, 2007).

Any scope for synergy needs to be seen within the context of contemporary development pressures (Goklany, 2007). For small farms in particular pressures are strong for diversification into non-farm activities, where such opportunities exist but strong support is needed to enable transitions in economic activity (Roshetko *et al.* 2007). Climate change impacts on the range of choices available, for example in low-lying coastal zones where salt-water intrusion and coastal flooding are already making traditional agriculture marginal and leading to the adoption of saltwater tolerant crops or a shift from agriculture to aquaculture (Adger, 2000). While urban areas have expanded in size and influence, the majority of the poor continue to reside in rural areas in many countries, particularly in Africa, and are amongst the most resource-scarce and capacity-limited population groups (UNDP, 2009). For populations that may also be isolated from markets and communication networks, even small increases in the frequency or severity of hazard can cause local livelihoods to collapse, though recent developments in communication technology may bridge this gap (Aker and Mbiti, 2010). Where political and economic systems disrupt food distribution and market functioning, vulnerability to food insecurity escalates (Misselhorn, 2005).

Hard choices also have to be made between expanding rural populations or economies and natural capital. Too often, local natural assets are exploited not by local actors to build local capacities but by external agents, such that resources are extracted with little benefit accruing locally. The balance and implementation of controls on natural resource exploitation is both a potential dampener on current capacity building and a critical mechanism for ensuring long-term sustainability of rural livelihoods and ecosystem services (Chouvy and Laniel, 2007). Non-farm income now represents a substantial proportion of total income for many rural households and can, in turn, increase resilience to weather and climate related shocks (Brklacich *et al.*, 1997; Smithers and Smit, 1997; Wandel and Smit, 2000). The implications of these transitions on local rural risk, and how far they may provide scope for mitigation has not been fully explored in the literature.

While urban sites offer opportunities for mitigation through diversified (household) production and energy conservation, rural areas are a focus for concentrated low or no-carbon energy production ranging from Hydro-Electric Power (HEP) to solar and wind farms, biofuel crops and carbon sink functions associated with forestry in particular and Reducing Emissions from Deforestation and Forest Degradation (REDD+) projects. These investments can have significant local impacts on disaster risk through changes in land-use and land-cover that may influence hydrology, or through economic effects and consequences for livelihoods. There is scope for synergy for example through small HEP/flood or water conservation dams, and some have gone as far to say that this joined-up approach is part of a transformed development policy for meeting combined energy and water demands in vulnerable rural communities, most particularly in sub-Saharan Africa (Foster and Briceño-Garmendia, 2011). Some impacts can even go beyond local places. Recent impacts of biofuel production on rural livelihoods and global food security indicate the interdependence of vulnerability in rural and urban systems, and the care required in transformations of this kind where impacts can quickly be spread and be amplified through global markets (Dufey, 2006; de Fraiture *et al.*, 2008).

Flows of investment, remittances, migration and material transfers through trade and also in the movement of resources (water, food, waste and energy) intimately connect rural and urban economies and societies, and the local with the global, such that the sustainability of one will influence the other. The existence of multiple, intersecting stressors in rural and urban contexts draws attention to the importance of addressing the underlying drivers of risk as a means of both disaster risk management and adaptation, and of promoting climate change mitigation.

## 8.6. Options for Proactive, Long-Term Resilience to Future Climate Extremes

Considering the broad challenges described above, it is important to assess the range of existing planning tools and the ways they are used, who uses them and how they interact or change over time. Pursuing sustainable and resilient development pathways requires integrated and ambitious policy that is science-based and knowledge-driven, and that is capable of addressing issues of heterogeneity and scale. The latter issues are particularly vexing, as the consequences of, and responses to, extreme climate and weather events are local, but these responses need to be supported and enabled by actions at regional, national and global scales. This section first considers the challenges of planning for the future, then assesses the literature pertaining to tools and practices that can help address these issues. As the preceding sections in this chapter and other chapters in the report have argued, achieving a sustainable and resilient future draws attention to the need for both incremental and transformational changes. Based on an assessment of the literature, the final section discusses why such changes may involve a combination of adaptive management, learning, innovation, and leadership.

### 8.6.1. Planning for the Future

Disaster risk management and climate change adaptation are fundamentally about planning for an uncertain future, a process that involves combining one's own aspirations (individual and collective) with perspectives on what is to come (Stevenson, 2008). Planning for the future is challenging when the stakes are high, values disputed, and decisions urgent, and these factors often create tensions among different visions of development. Typically, decision-makers (representing households, local or national governments, international institutions, etc.) look to the future partly by remembering the past (e.g., projections of the near future are often derived from recent or experiences with extreme events) and partly by projecting how the future might be different (using forecasts, scenarios, visioning processes, or story lines – either formal or informal) (Miller, 2007). Projections further into the future are necessarily shrouded in larger uncertainties. The most common approach for addressing these uncertainties is to develop multiple visions of the future (quantitative scenarios or narrative storylines), that in early years can be compared with actual directions of change (Boulangier *et al.*, 2006a; 2006b; Moss *et al.*, 2010).

Scenario development has become an established research tool both in the natural sciences (e.g., Nakicenovic *et al.*, 2000; Lobell *et al.*, 2008) and in the social sciences (e.g. Wack, 1985; Davis, 1998; Robinson, 2003; Galer, 2004; Kahane, 2004; Rosegrant *et al.*, 2011). Scenarios can be based on different spatial scales (e.g., global, national and local) and temporal scales (e.g., from a few years to several decades or centuries). The challenges for integrated disaster risk management and climate change adaptation scenarios are to generate climate data that can be downscaled to at least regional and sub-national scales, while extending disaster risk projections to longer time scales (see Gaffin *et al.*, 2004; Theobald, 2005; van Vuuren *et al.*, 2006; Bengtsson *et al.*, 2006; Grübler *et al.*, 2007; Moss *et al.*, 2010; Hallegatte *et al.*, 2011a).

Scenario development has traditionally been carried out in a sequential manner (Moss *et al.*, 2010). For example, a first step in developing climate change scenarios has typically involved structural projections of key determinants of greenhouse gas emissions (e.g., population changes, urbanisation, etc.). These have been used to estimate concentrations and radiative forcing from emissions, leading to climate projections that can be used in impacts research. One difficulty in using climate scenarios for disaster risk management and climate change adaptation has been the uncertainties associated with extreme climate and weather events, including the behavior of local climates (see Chapter 3, Section 3.2.3). Future socio-economic changes (e.g., demography, population preferences, technologies) are also highly uncertain, thus scenarios must consider a wide range of possible futures to design

adaptation strategies and analyze trade-offs (e.g., Hall, 2007; Lempert, 2007; Lempert and Collins, 2007; WGBU, 2008; Brauch and Oswald Spring, 2009; Dessai *et al.*, 2009a; Dessai *et al.*, 2009b; Hallegatte, 2009). Alternative approaches have focused first on scenarios of radiative forcing, followed by an analysis of the combinations of economic, technological, demographic, policy and institutional factors that can influence such trajectories (Moss *et al.*, 2010). Other approaches are based on robust decision-making (e.g., Groves and Lempert, 2007; Groves *et al.*, 2008; Lempert and Collins, 2007); information gap analysis (Hine and Hall, 2010); or on the search for co-benefits, no regrets strategies, flexibility and reversibility (e.g., Fankhauser *et al.*, 1999; Goodess *et al.*, 2007; Hallegatte, 2009).

Scenario development requires substantial climate, social, environmental and economic data, which is not equally available or accessible for all parts of the world. Qualitative scenarios can also be produced based on expert judgement (e.g., Delphi exercises) or on storylines designed through consultative processes. Such scenarios often reflect different mind-sets or worldviews that represent contrasting visions of the future.

To adapt to changing climate and weather extremes, difficult choices may become increasingly necessary. In many locations, for example, adapting to scenarios of reduced water availability may involve increased investments in water infrastructure to provide enough irrigation to maintain existing agriculture production, or a shift from current production to less water consuming crops (see Rosenzweig *et al.*, 2004; ONERC, 2009; Gao and Hu, 2011). In considering adaptation to future flood risk in the Thames Estuary, the UK Environment Agency (2009) applied four scenarios over three time periods to flood management. Through a wide consultation process, it was determined that improving the current infrastructure continues to be the preferred strategy until 2070, when construction of an outer barrage may become justifiable, especially as economic and climate change conditions change over time.

Evaluating choices among different options depends on how the stakeholders view the region in coming decades, and on adaptation decisions that are informed by political processes. One scenario approach that explicitly acknowledges both social and environmental uncertainties entails identification of flexible adaptation pathways for managing the future risks associated with climate change (Yohe and Leichenko, 2010). Based on principles of risk management (which emphasize the importance of diversification and risk-spreading mechanisms in order to improve social and/or private welfare in situations of profound uncertainty) this approach can be used to identify a sequence of adaptation strategies that are designed to keep society at or below acceptable levels of risk. These strategies, which policy makers, stakeholders, and experts develop and implement, are expected to evolve over time as knowledge of climate change and associated climate hazards progresses. The flexible adaptation or adaptive management approach that underpins this also stresses the connections between adaptation and mitigation of climate change, recognizing that climate change mitigation will be needed in order to sustain society at or below an acceptable level of risk (Yohe and Leichenko, 2010).

In contrast to predictive scenarios and risk management approaches, exploratory and normative approaches can be used to develop scenarios that represent desirable alternative futures. This is particularly important in the case of sustainability, where the most likely futures may not be the most desirable (Robinson, 2003), and where poverty, inequity, and injustice are recognized by many as incompatible with sustainable development (Redclift 1987, 1992; St. Clair, 2010). Pathways that require considerable transformation to reach sustainable futures of this kind can be supported by backcasting techniques. The process of backcasting involves developing normative scenarios that explore the feasibility and implications of achieving certain desired outcomes (Robinson, 2003; Carlsson-Kanyama *et al.*, 2008). It is concerned with how desirable futures can be attained, focusing on policy measures that would be required to reach such conditions. Participatory backcasting, which involves local stakeholders in visionary activities related to sustainable development, can also open deliberative opportunities and inclusiveness in decision-framing and making. Where visioning is repeated it can also open possibilities for tracking development and learning processes that make up adaptive strategies for disaster risk management, based on the explicit acknowledgement of the beliefs, values and preferences of citizens (Robinson, 2003). Changing attitudes and core beliefs, including those on climate change, its causes and consequences, is a slow process (Volkery and Ribeiro, 2009).

Adding an anticipatory dimension to planning for the future is critical for striving towards transformational actions in the face of multiple and dynamic uncertainties. The literature on anticipatory action learning provides some experience on what this might look like (Stevenson, 2002; Kelleher, 2005). The framing and negotiation of decision-

making and policy is made inclusive and reflexive through multiple rounds of stakeholder engagement to explore meanings of what different futures may involve, reflect upon unavoidable trade-offs and the winners and losers, and establish confidence to creatively adapt to new challenges (Inayatullah, 2006). This type of learning stresses the skills, knowledges, and visions of those at risk and aims to support leadership from even the most vulnerable. A combination of local- and global-scale scenarios that link storylines developed at several organizational levels (Biggs *et al.*, 2007), personalizing narratives to create a sense of ownership (Frittaion *et al.*, 2010), and providing safe and repeated learning spaces (Kesby, 2005) can enhance learning.

While scenarios, projections and forecasts are all useful and important inputs for planning, actual planning and decision-making is a complex socio-political process involving different stakeholders and interacting agents. Although much progress has been made by employing scenario building and narrative creation to explore uncertainties, surprises, extreme events, and tipping points, the transition from envisioning to planning, policy-making, and implementation remains poorly understood (Lempert, 2007). Similarly, more wide-spread uptake of even scientifically highly robust scenarios may be hampered by conflicting understandings of and practical approaches to uncertainty, different scalar needs, and lack of training among users (Gawith *et al.*, 2009). Experiences in scenario building emphasize their usefulness for raising awareness on climate change (Gawith *et al.*, 2009). However, to move from framing public debates to policy-making and implementation, useful scenario building requires procedural stability, permanent yet flexible institutional and governance structures that build trust and experience to take advantage of new insights for effective and fair risk management (Volkery and Ribeiro, 2009).

Developing the capacity for adaptive learning to accommodate complexity and uncertainty requires exploratory and imaginative visions for the future that support choices and can accommodate multiple values and aspirations (Miller, 2007). Disaster risk management and climate change adaptation, and synergies between the two, can contribute towards planning for a sustainable and resilient future, but this involves expanding the diversity of futures that are considered and identifying those that are desirable, as well as the short-term and long-term values and actions that are consistent with them (Lempert, 2007).

### 8.6.2. *Approaches, Tools, and Integrating Practices*

As discussed above, scenarios, narrative storylines (Tschakert and Dietrich, 2010) and simulations (Nicholls *et al.*, 2007) can help to project and facilitate discussion of possible futures. This section considers the tools that are available for helping decision-makers and planners think about and plan for the future in the context of extreme climate and weather events. Past experiences with enhancing resilience to climate extremes include examples of both specific decision-support tools and the governance and institutional contexts in which these tools are used and subsequent decisions are made (OECD, 2009b; Burch *et al.*, 2010; Whitehead *et al.*, 2010). Tools include those that enable information gathering, monitoring, analysis and assessment, simulate threats, develop projections of possible impacts, and explore implications for response. Effective approaches combine understandings of potential stresses from climate extremes, along with possible tipping points for affected social and physical systems, with monitoring systems for tracking changes and identifying emerging threats in time for adaptive responses. This is, of course, challenging, requiring methodologies that can be open to both quantitative and qualitative data and its analysis, including participatory deliberation (NRC, 2010).

Institutional innovations aimed at improving the availability of disaster information to decision makers include the creation of national or regional institutions to manage and distribute disaster risk information (Von Hesse *et al.*, 2008; Corfee-Morlot *et al.*, 2011), bringing together previously fragmented efforts centred in national meteorological, geological, oceanographic and other agencies. The World Meteorological Organization and partner organizations have proposed the creation of a Global Framework for Climate services, a collaborative effort to help the global community to better adapt to climate variability and change by developing and incorporating science-based climate information and prediction into planning, policy and practice (WCC-3, 2009). New open source tools for comprehensive probabilistic risk assessment are beginning to offer ways of compiling information at different scales and from different institutions (OECD, 2009b). A growing number of countries are also systematically recording disaster loss and impacts at the local level (DesInventar, 2010) and developing mechanisms to use such



information to inform and guide public investment decisions (Comunidad Andina, 2007; Von Hesse *et al.*, 2008; Comunidad Andina, 2009) and national planning. Unfortunately, there is as yet only limited experience with the integrated deployment of such tools and institutional approaches, especially in ways that cross scales of risk management strategy development and decision-making, and very limited evaluations of such deployment.

#### 8.6.2.1. *Improving Analysis and Modeling Tools*

Various tools can be used to design environmental and climate policies. Among them, integrated environment-energy-economy models produce long-term projections taking into account demographic, technological and economic trends (e.g., Edenhofer *et al.*, 2006; Clarke and Weyant, 2009). These models can be used to assess the consequences of various policies. However, most such models are at spatial and temporal scales that do not resolve specific climate extremes or disasters (Hallegatte *et al.*, 2007). At higher spatial resolution, numerical models (e.g., input-output models, calculable general equilibrium models) can help to assess disaster consequences and, therefore, balance the cost of disaster risk management actions and their benefits (Rose *et al.*, 1997; Gordon *et al.*, 1998; Okuyama, 2004; Rose and Liao, 2005; 2007; Tsuchiya *et al.*, 2007; Hallegatte, 2008b). In particular, they can compare the cost of responding to disasters with the cost of preventing disasters. Since disasters have intangible consequences (e.g., loss of lives, ecosystem losses, cultural heritage losses, distributional consequences) that are difficult to measure in economic terms, the quantitative models are necessary but not sufficient to determine desirable policies and disaster risk management actions. Whether incorporated in models or used in other forms of analysis, cost-benefit analysis is useful to compare costs and benefits; but when intangibles play a large role and when no consensus can be reached on how to value these intangibles, other decision-making tools and approaches are needed. Multi criteria decision-making (Birkmann, 2006), robust decision-making (e.g., Lempert 2007; Lempert and Collins, 2007), transition management approaches (e.g. Loorbach, 2010; Kemp *et al.*, 2007), and group-process analytic-deliberative approaches (Mercer *et al.*, 2008) are examples of such alternative decision-making methodologies.

Also necessary are indicators to measure the successes and failures of policies. For example, climate change adaptation policies often target the enhancement of adaptive capacity. The effects and outcomes of policies are often measured using classical economic indicators such as GDP. The limits of such indicators are well known, and have been summarized in several recent reports (e.g., CMEPSP, 2009; OECD, 2009a). To measure progress toward a resilient and sustainable future, one needs to include additional components, such as measures of stocks, other capital types (natural capital, human capital, social capital), distribution issues, welfare factors (health, education, etc.). Many alternative indicators have been proposed in the literature, but no consensus exists. Examples of these alternative indicators include: the Human Development Index, the Genuine Progress Indicator, the Index of Sustainable Economic Welfare, the Ecological Footprint, the normalized GDP, and various indicators of vulnerability and adaptive capacity (Costanza, 2000; Yohe and Tol, 2002; Lawn, 2003; Costanza *et al.*, 2004; Eriksen and Kelly, 2006; Jones and Klenow, 2010).

#### 8.6.2.2. *Institutional Approaches*

Among the most successful disaster risk management and adaptation efforts have been those that have facilitated the development of partnerships between local leaders and other stakeholders, including extra-local governments (Bicknell *et al.*, 2009; Pelling and Wisner, 2009; Gero *et al.*, 2011). This allows local strength and priorities to surface in disaster risk management, while acknowledging also that communities (including local government) have limited resources and strategic scope and alone cannot always address the underlying drivers of risk (Bhattamishra and Barrett, 2010). Local programmes are now increasingly moving from a focus on strengthening disaster preparedness and response to reducing both local hazard levels and vulnerability (for example, through slope stabilization, flood control measures, improvements in drainage etc.) (ISDR, 2009; Lavell, 2009; Reyos, 2010). Most of the cases where sustainable local processes have emerged are where national governments have decentralized both responsibilities and resources to the local level, and where local governments have become more accountable to their citizens as for example in cities in Colombia such as Manizales (Velásquez, 1998; Velásquez, 2005). In Bangladesh and Cuba successes in disaster preparedness and response leading to drastic reduction in mortality due to tropical cyclones,

built on solid local organization, have relied on sustained support from the national level (Haque and Blair, 1992; Bern *et al.*, 1993; Ahmed *et al.*, 1999; Chowdhury, 2002; Elsner *et al.*, 2008; Karim and Mimura, 2008; Kossin *et al.*, 2007; Knutson *et al.*, 2010; World Bank, 2010a). A growing number of examples now exist of community driven approaches that are supported by local and national governments as well as by international agencies, through mechanisms such as social funds (Bhattamishra and Barrett, 2010).

Risk transfer instruments, such as insurance, reinsurance, insurance pools, catastrophe bonds, micro insurance and other mechanisms, shift economic risk from one party to another and thus provide compensation in exchange for a payment, often a premium (*ex post* effect) (see Chapter 5, Section 5.6.3; Chapter 6, Section 6.5.3; Chapter 7, Section; and Chapter 9, Section 9.2.13). In addition, these mechanisms can also help to anticipate and reduce (economic) risk as they reduce volatility and increase economic resilience at the household, national and regional levels (Linnerooth-Bayer *et al.*, 2005). As one example, with such insurance, drought-exposed farmers in Malawi have been able to access improved seeds for higher yielding and higher risk crops thus helping them to make a leap ahead in terms of generating higher incomes and the adoption of higher return technologies (World Bank, 2005; Hazell and Hess, 2010). However, many obstacles to such schemes still exist, particularly in low income and many middle income countries, including the absence of comprehensive risk assessments and required data, legal frameworks and the necessary infrastructure and probably more experience is required to determine the contexts in which they can be effective (Linnerooth-Bayer and Mechler, 2007; Cummins and Mahul, 2008; Mahul and Stutley, 2010).

Disaster risk management and adaptation can also be addressed through the enhancement of generic adaptive capacity alongside hazard-specific response strategies (IFRC, 2010). This capacity includes access to information, the skills and resources needed to reflect upon and apply new knowledge, and institutions to support inclusive decisions-making. These are cornerstones of both sustainability and resilience. While uncertainty may make it difficult for decision-makers to commit funds for hazard-specific risk reduction actions, these barriers do not prevent investment in generic foundations of resilient and sustainable societies (Pelling, 2010). Importantly, from such foundations local actors may be able to make better-informed choices on how to manage risk in their own lives, certainly over the short/medium terms. For instance, federations formed by slum dwellers have become active in identifying and acting on disaster risk within their settlements and seeking partnerships with local governments to make this more effective and larger scale (IFRC, 2010).

Changes in systems and structures may call for new ways of thinking about social contracts, which describe the balance of rights and responsibilities between different parties. Social contracts that are suitable for technical problems can be limiting and insufficient for addressing adaptive challenges (Heifetz, 2010). Pelling and Dill (2009) describe the ways that current social contracts are tested when disasters occur, and how disasters may open up a space for social transformation, or catalyse transformative pathways building on pre-disaster trajectories. O'Brien *et al.* (2009) consider how resilience thinking can contribute to new debates about social contracts in a changing climate, drawing attention to trade-offs among social groups and ecosystems, and to the rights of and responsibilities towards distant others and future generations.

#### 8.6.2.3. *Transformational Strategies and Actions for Achieving Multiple Objectives*

If extreme climate and weather events increase significantly in coming decades, climate change adaptation and disaster risk management are likely to require not only incremental changes, but also *transformative* changes in systems and institutions. Transformation can be defined as a fundamental qualitative change, or a change in composition or structure that is often associated with changes in perspectives or initial conditions (see Box 8-1). It often involves a change in paradigm and may include shifts in perception and meaning, changes in underlying norms and values, reconfiguration of social networks and patterns of interaction, changes in power structures, and the introduction of new institutional arrangements and regulatory frameworks (Folke *et al.*, 2010; Smith and Stirling, 2010; Pahl-Wostl, 2009; Folke *et al.*, 2009).

Although transformational policies and measures may be deliberately invoked as a strategy to reduce disaster risk and adapt to climate change, in many cases such strategies are precipitated by an extreme event, sometimes referred

to as a “focusing event” (Birkland, 1996). However, whether an extreme event leads to any change at all is unclear, as processes of policy change are often subtle and complex and linked to learning processes (Birkland, 2006). Exploring the relationship between systematic learning processes and small disasters, Voss and Wagner (2010) find that a failure to learn is the most common prerequisite for future disasters. There are, however, many dimensions to learning (e.g., cognitive, normative and relational – see Huitema *et al.*, 2010), and learning may be a necessary but insufficient condition for initiating transformational change.

Understanding processes of deliberate change and change management can provide insights on societal responses to extreme climate and weather events. Traditional approaches to managing change successfully in businesses and organizations focus on a series of defined steps (Harvard Business Essentials, 2003). Kotter (1996), for example, identifies an eight-step process for promoting change: 1) create a sense of urgency; 2) pull together the guiding team; 3) develop the change vision and strategy; 4) communicate for understanding and buy in; 5) empower others to act; 6) produce short-term wins; 7) don’t let up; and 8) create a new culture. Kotter (1995) also identifies eight errors that are often made when leading change, including, for example, allowing too much complacency, failing to create a sufficiently powerful guiding coalition, and underestimating the power of a sound vision. It is also important to recognize that many change initiatives create uncertainty and disequilibria, and are considered disruptive or disorienting (Heifetz *et al.*, 2009). Furthermore, vested interests seldom choose transformation, particularly when there is much to lose from change (Christensen, 1997). As discussed in Section 8.5.2, there are winners and losers not only from extreme climate and weather events, but also from responses. Consequently, fundamental change is often resisted by the people that it affects the most (Kotter, 1996, Kegan and Lahey, 2009). Helping people, groups, organizations and governments to manage the resulting disequilibria is seen as essential to successful transformation.

Many of the recent approaches to change and transformation focus on learning organizations, and the importance of changing individual and collective mindsets or mental models (Senge, 1990; Scharmer, 2009; Heifetz *et al.*, 2009; Kegan and Lahey, 2009). This transformational change literature distinguishes between technical problems that can be addressed through management based on existing organizational and institutional structures and cultural norms, and adaptive challenges that require a change in mindsets, including changes in assumptions, beliefs, priorities, and loyalties (Kegan and Lahey, 2009; Heifetz *et al.*, 2009). Treating disaster risk management and climate change adaptation as technical problems may focus attention only on improving technologies, reforming institutions, or managing displaced populations, whereas viewing them as an adaptive challenge shifts attention towards gaps between values and behaviors (e.g., values that promote human security vs. policies or behaviors that undermine health and livelihoods), beliefs (e.g., a belief that disasters are inevitable or that adaptation will occur autonomously) and competing commitments (e.g., a commitment to maintaining aid dependency or preserving of social hierarchies). Although most problems have both technical and adaptive elements, treating an adaptive challenge only as a technical problem limits successful outcomes (Heifetz *et al.*, 2009).

Transformative changes that move society towards the path of openness and adaptability depend not only on changes in mindsets, but also on changes in systems and structures. Case studies of social-ecological systems suggest that there are three phases involved in systems transformations. The first phase includes being prepared for, or preparing the system, for change. The second phase calls for navigating the transition by making use of a sudden crisis as an opportunity for change, whether the crisis is real or perceived. The third phase involves building resilience of the new system (Olsson *et al.*, 2004; Chapin *et al.*, 2010). Traditional management approaches emphasize the reduction of uncertainties, with the expectation that this will lead to systems that can be predicted and controlled. However, in the case of climate change, future projections of climate variables and extremes will contain uncertainty (see Chapter 3, Section 3.2.3). Consequently, there is a need for management approaches that are adaptive and robust in the presence of large and irreducible uncertainties.

### 8.6.3. *Facilitating Transformational Change*

Adapting to climate and weather extremes associated with rapid and severe climate change, such as a warming beyond 4°C within this century, without transformational policy and social change will be difficult: If not chosen through proactive policies, forced transformations and crises are likely to result (New *et al.*, 2011). Adaptation that

is transformative marks a shift from emphasizing finite projects with linear trajectories and readily identifiable, discrete strategies and outcomes (Schipper, 2007), towards an approach that includes adaptive management, learning, innovation and leadership, among other elements. These aspects of adjustment are increasingly seen as being embedded in ongoing socio-cultural and institutional learning processes. This can be observed in the many adaptation projects that emphasize learning about risks, evaluating response options, experimenting with and rectifying options, exchanging information, and making trade-offs based on public values using reversible and adjustable strategies (McGray *et al.*, 2007; Leary *et al.*, 2008; Hallegatte, 2009; Hallegatte *et al.*, 2011b).

Transformational adaptations are likely to be enabled by a number of factors. Some of the factors arise from external drivers such as focal events that catalyse attention to vulnerabilities or the presence of other sources of stress that also encourage considerations of major changes. Supportive social contexts such as the availability of understandable and socially acceptable options, access to resources for action, and the presence of incentives may also be important. Other factors are related to effective institutions and organizations, including those described below.

#### 8.6.3.1. Adaptive Management

In general terms, adaptive management can be defined as a structured process for improving management policies and practices by systemic learning from the outcomes of implemented strategies, and by taking into account changes in external factors in a proactive manner (Pahl-Wostl *et al.*, 2007; Pahl-Wostl, 2009; Chapter 6, Section 6.6.2). Principles of adaptive management can contribute to a more process-oriented approach to disaster risk management, and have already shown some success in promoting sustainable natural resource management under conditions of uncertainty (Medema *et al.*, 2008). Adaptive management is often associated with ‘adaptive’ organizations that are not locked into rigid agendas and practices, such that they can consider new information, new challenges, and new ways of operating (Berkhout *et al.*, 2006; Pelling *et al.*, 2007). Organizations that can monitor environmental, economic and social conditions and changes, respond to shifting policies and leadership changes, and take advantage of opportunities for innovative interventions are a key to resilience, especially with respect to conceivable but long-term and/or relatively low-probability events. Those social systems that appear most adept at adapting are able to integrate formal organizational roles with cross-cutting informal social spaces for learning, experimentation, communication and for trust based and speedy disaster response that is nonetheless accountable to beneficiaries (Pelling *et al.*, 2007).

Adaptive management is a challenge for those organisations that perceive reputational risk from experimentation and the knowledge that some local experiments may fail (Fernandez-Gimenez *et al.*, 2008). Where this approach works best, outcomes have gone beyond specific management goals to include trust-building among stakeholders—a resource that is fundamental to any policy environment facing an uncertain future, which also has benefits for quality of life and market competitiveness (Fernandez-Gimenez *et al.* 2008). It requires revisiting the relationship between the state and local actors concerning facilitation of innovation, particularly when experiments go wrong. Investing in experimentation and innovation necessarily requires some tolerance for projects that may not be productive or cost effective, or at least not in the short term or under existing risk conditions. However, it is exactly the existence of this diversity of outcomes that makes societies fit to adapt once risk conditions change, particularly in unexpected and non-linear directions.

#### 8.6.3.2. Learning

The dynamic notion of adaptation calls for learning as an iterative process in order to build resilience and enhance adaptive capacity now, rather than targeting adaptation in the distant future (see Chapter 1, Section 1.4.2). Social and collective learning includes support for joint problem solving, power sharing, and iterative reflection (Berkes, 2009). The need to take into account the arrival of new information in the design of response strategies has also been mentioned for mitigation policies (Ha Duong *et al.*, 1997; Ambrosi *et al.*, 2003). Adaptive management is an incremental and iterative learning-by-doing process, whereby participants make sense of system changes, engage in actions, and finally reflect on changes and actions. Lessons from learning theories, including experiential learning

(Kolb, 1984) and transformative learning (Mezirow, 1995), stress the importance of learning-by-doing in concrete learning cycles, problem-solving actions, and the re-interpretation of meanings and values associated with learning activities.

Learning is a key component for living with uncertainty and extreme events, and is nurtured by building the right kind of social/institutional space for learning and experimentation that allows for competing worldviews, knowledge systems, and values, and facilitates innovative and creative adaptation (Thomas and Twyman, 2005; Armitage *et al.*, 2008; Moser, 2009; Pettengell, 2010). Examples include promoting shared platforms for dialogues and participatory vulnerability assessments that include a wide range of stakeholders (see ISET, 2010). It is equally important to acknowledge that abrupt and surprising changes may surpass existing skills and memory (Batterbury, 2008). Adaptation projects have demonstrated that fostering adaptive capacity and managing uncertainty on the go by adjusting as new information, techniques, or conditions emerge, especially among populations exposed to multiple risks and stressors, is more effective than more narrowly designed planning approaches that target a given impact and are dependent on particular future climate information (McGray *et al.*, 2007; Pettengell, 2010). In the humanitarian sector, institutionalized processes of learning have contributed to leadership innovation (see Box 8-3).

\_\_\_\_\_ START BOX 8-3 HERE \_\_\_\_\_

#### Box 8-3. Institutionalized Learning in the Humanitarian Sector

An important attribute of the humanitarian sector is its readiness to learn. Learning unfolds at multiple levels, including sector wide reviews of performance and practice such as those undertaken by the Active Learning Network for Accountability and Performance in Humanitarian Action. Learning is also structured around the internal needs of organisations (e.g., Red Cross / Crescent Societies) or the outcomes of individual events (e.g the landmark report on humanitarian sector practice following the Indian Ocean Tsunami (Telford *et al* 2006). Organisations have different methodologies, target audiences and frames of reference, making cross-sector learning difficult (Amin and Goldstein, 2008), but they all have led to practical and procedural changes. Less well-developed is active experimentation in the field of practice, with a view of proactive learning (Corbacioglu and Kapucu, 2006). This is difficult in the humanitarian sector, where stakes are high and rapid action has typically made it difficult to implement learning-while-doing experiments. Where experimentation may be more observable, for example in disaster prevention and risk reduction or reconstruction activities, there are significant gaps in documentation that has slowed down the transferring of learning outcomes between organizations. Hierarchical models of governance have fostered a lack of cooperation and generated competition between agencies within the humanitarian and development sectors partly explaining why there is more learning based on the sharing of experience inside organizations than across sectors (Kapucu, 2009). But the increasing scale and diversity of risk associated with climate change, and compounded by other development trends such as growing global inequality and urbanization, puts more pressure on donors to promote cross-sector communication of productive innovations and of the experimentation such innovation builds upon.

\_\_\_\_\_ END BOX 8-3 HERE \_\_\_\_\_

Action research and learning provide a powerful complement to resilience thinking, as it focuses explicitly on iterative or cyclical learning through reflection of success and failures in experimental action, transfer of knowledge between learning cycles, and the next learning loop that will lead to new types of action (Ramos, 2006; List, 2006). Referring to the learning processes described in Chapter 1, Section 1.4.2, critical reflection is paramount to triple loop learning; it also constitutes the key pillar of double loop learning, or the questioning of what works and why that is fundamental to shifts in reasoning and behavior (Kolb and Fry, 1975; Argyris and Schön, 1978; Keen *et al.*, 2005). Allowing time for reflection in this iterative learning process is important because it provides the necessary space to develop and test theories and strategies under ever changing conditions. It is through such learning processes that individual and collective empowerment can emerge and potentially be scaled up to trigger transformation (Kesby, 2005).

### 8.6.3.3. Innovation

The transformation of society towards sustainability and resilience involves both social innovations and technological innovations, incremental as well as radical. Innovation can refer to non-material changes related to knowledge, cognition, communication, or intelligence, or it can refer to any kind of material resources. In some cases, small adjustments in practices or technologies may represent innovative steps towards sustainability, while in other cases there is a strong need for more radical transformations. Some of the literature on innovation focuses on ensuring economic competitiveness for firms in an increasingly globalized economy (Fløysand and Jakobsen, 2010), and some concentrates on the relationship between environment on the one hand and the competitiveness of firms on the other (Mol and Sonnenfeld, 2000). In addition, there is a body of social science literature on innovation that has emerged during the last 15 years, motivated by the need for transforming society as a whole in more sustainable directions. Recent literature has brought out new ideas and frameworks for understanding and managing technology and innovation-driven transitions, such as the Multi Level Perspective (MLP) (Rip and Kemp, 1998; Geels, 2002; Geels and Schot, 2007; Markard and Truffer, 2008). Combining insights from evolutionary theory and sociology of technology, the MLP conceptualizes major transformative change as the product of inter-related processes occurring at the three levels of niches, regimes and landscape. The model emphasizes the incremental nature of innovation in socio-technical regimes. Transitions, i.e. shifts from one stable socio-technical regime to another—occur when regimes are destabilized through landscape pressures, which provide breakthrough opportunities for niche-innovations.

In this field of research there is a strong focus on systems innovation and transformation of socio-technical systems, with the potential of facilitating transitions from established systems for transport, energy supply, agriculture, housing, etc., to alternative, sustainable systems (Geels, 2002; Hoogma *et al.*, 2002; Raven *et al.*, 2010; Smith *et al.* 2005). The systems innovation literature analyses the emergence and dynamics of large-scale, long-term socio-technical transformations (Kemp *et al.*, 1998). Though not directly dependent on changes in technology, technological and social innovations are often closely interrelated, not the least in that they involve changes in social practices, institutions, cultural values, knowledge systems, and technologies (Rohracher, 2008). Box 8-4 describes such innovation in water management. A central, basic insight established within this research is that social and technological change is an interactive process of co-development between technology and society (Kemp, 1994; Hoogma *et al.*, 2002; Rohracher, 2008). Throughout history, new socio-technical systems have emerged and replaced old ones in so-called technological revolutions, and an important characteristic of such transitions are the interactions and conflicts between new, emerging systems and established and dominating socio-technical regimes, with strong actors defending business as usual (Kemp, 1994; Perez, 2002).

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#### Box 8-4. Innovation and Transformation in Water Management

The impacts of climate change in many regions are predominantly linked to the water system, in particular through increased exposure to floods and droughts (Lehner *et al.*, 2006; Smith and Barchiesi, 2009, see Chapter 2, Section 2.5). Considering water as a key structuring element or guiding principle for landscape management and land use planning requires technology, integrated systems thinking, and the art of thinking in terms of attractiveness and mutual influence, or even mutual consent, between different authorities, experts, interest groups, and the public. One of the most pronounced changes can be observed in the Netherlands where the government has requested a radical rethink of water management in general and flood management in particular. The resulting policy stream, initiated through the ‘Room for the River’ (*Ruimte voor de Rivier*) policy, has strongly influenced other areas of government policy. Greater emphasis is now given to the integration of water management and spatial planning with the regulating services provided by landscapes with natural flooding regimes being highly valued. This requires a revision of land use practices and reflects a gradual movement towards integrated landscape planning whereby water is recognized as a natural, structural element. The societal debate about the plans to build in deep-lying polders and other hydrologically unfavorable spots, and new ideas on floating cities indicate a considerable social engagement of both public and private parties with the issue of sustainable landscapes and water management. However, although such innovative ideas have been adopted in policy, they take time to implement, as there is considerable social resistance (Wolsink, 2006).

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#### 8.6.3.4. Leadership

Leadership can be critical for disaster risk management and climate change adaptation, particularly in initiating processes and sustaining them over time (Moser and Ekstrom, 2010). Change processes are shaped both by the action of individual champions (as well as by those resisting change) and their interactions with organisations, institutional structures and systems. Leadership can be a driver of change, providing direction and motivating others to follow, thus the promotion of leaders by institutions is considered an important component of adaptive capacity (Gupta *et al.*, 2010), although knowledge about how to create and enable leadership remains elusive. Leadership and leaders often do not develop independently of the institutional context, which includes institutional rules, resources, and organizational culture (Kingdon, 1995).

Leaders who facilitate transformation have the capacity to understand and communicate a wide set of technical, social and political perspectives related to a particular issue or problem. They are also able to reframe meanings, overcome contradictions, synthesize information, and create new alliances that transform knowledge into action (Folke *et al.*, 2009). Leadership also involves diagnosing the kinds of losses that some people, groups, organizations, or governments may experience through transformative change, such as the loss of status, wealth, security, loyalty, or competency, not to mention loved ones (Heifetz, 2010). Leaders helps individuals and groups to take action to mobilize “adaptive work” in their communities, such that they and others can thrive in a changing world by managing risk and creating alternative development pathways – or engaging and directing people during times of choice and change (Heifetz, 2010).

### 8.7. Synergies between Disaster Risk Management and Climate Change Adaptation for a Resilient and Sustainable Future

Drawing on the assessment presented in this chapter, it becomes clear that there are many potential synergies between disaster risk management and climate change adaptation that can contribute to a sustainable and resilient future. There is, however, no single approach, framework or pathway to achieve this; a diversity of responses to extremes taken in the present and under varying social and environmental conditions can contribute to future resilience in situations of uncertainty. Nonetheless, some important contributing factors have been identified and discussed in this chapter, and are confirmed by the wider literature (e.g., Lemos *et al.* (2007); Tompkins *et al.* (2008); Pelling (2010); Wisner (2011). Eight critical factors stand out as important:

- 1) A capacity to reconcile short-term and long-term goals
- 2) A willingness to reconcile diverse expressions of risk in multi-hazard and multi-stressor contexts
- 3) The integration of disaster risk reduction and climate change adaptation into other social and economic policy processes
- 4) Innovative, reflexive, and transformative leaders (at all levels)
- 5) Adaptive, responsive, and accountable governance
- 6) Support for flexibility, innovation and learning, locally and across sectors
- 7) The ability to identify and address the root causes of vulnerability
- 8) A long-term commitment to managing risk and uncertainty and promoting risk-based thinking.

Lessons learned in climate change adaptation and disaster risk management illustrate that managing uncertainty through adaptive management, anticipatory learning and innovation can lead to more flexible, dynamic, and efficient information flows and adaptation plans, while creating openings for transformational action. Reducing vulnerability has been identified in many contemporary disaster studies as the most important prerequisite for a resilient and sustainable future. Research has consistently found that for long-term sustainability, disaster risk management is most impactful when combined with structural reforms that address underlying causes of vulnerability and the structural inequalities that create and sustain poverty and constrain access to resources (Hewitt, 1983; Wisner *et al.*, 2004; Lemos *et al.*, 2007; Collins, 2009; Pelling, 2010).

Engaging with possible and desirable futures and options for decision-making fosters knowledge generation that is essential for adaptive risk management as well as iterative change processes. Zooming in on uncertain elements and their potential impacts (e.g. changes in rainfall and variability) and identifying factors that currently limit adaptive capacity (e.g. marginalization, lack of access to resources or information gaps) allows for more robust decision-making that also integrates local contexts (asset portfolios, spreading and managing risks) with the climate context (current trends, likely futures, and uncertainties) to identify the most feasible, appropriate, and equitable response strategies, policies, and external interventions (Pettengell, 2010). Creating space and recognizing a diversity of voices often means reframing what counts as knowledge, engaging with uncertainties, nourishing the capacity for narrative imagination, and articulating agency and strategic adaptive responses in the face of already experienced changes and to anticipate and prepare for future disturbances and shocks (Tschakert and Dietrich, 2010).

Challenges remain with respect to anticipating low probability/high impacts events and potentially catastrophic tipping points that represent futures too undesirable to imagine, especially under circumstances where exposure and vulnerability are high and adaptive capacity low (Volkery and Ribeiro, 2009). At a practical level, there are many gaps and barriers to realizing synergies for integration to foster a sustainable and resilient future. For example, overcoming the current disconnect between local risk management practices and national institutional and legal frameworks, policy and planning can be considered key to reconciling short-term and long-term goals for vulnerability reduction. Even where capacity is present, it can take effort to shift into more critical, learning modes of governance (Corbacioglu and Kapucu, 2006). Moreover, anticipating vulnerabilities as well as feasible and fair actions may also reveal limits of adaptation and risk management, and thus raise the potential need for transformation. Because transformative changes open up questions about the values and priorities shaping development and risk futures, who wins and loses and the balance of trade-offs, decisions about when and where to facilitate transformative change and to whose benefit are inherently normative and political. Transformation cannot be approached without understanding related ethical and governance dimensions. At the same time, incremental changes, in supporting many aspects of business-as-usual, also possess implicit ethical and normative aspects. At heart, it is perhaps in failing to fully reveal and question these normative positions that current disaster risk management practice and policy has remained outside of development planning and policy processes, inhabiting a long acknowledged, but still present “disasters archipelago” in the policy world (Hewitt, 1983:12).

Disasters often require urgent action and represent a time when everyday processes for decision-making are disrupted. Although it is a useful approach in responding to emergency events and disaster relief, such top-down command and control frameworks work less well in disaster risk reduction and this is likely to be the case too in integrated adaptive risk management. In such systems it is often the most vulnerable to hazards are left out of decision-making processes (Pelling, 2003a, 2007; Cutter, 2006; Mercer *et al.*, 2008), whether it is within households (where the knowledge of women, children or the elderly may not be recognised), within communities (where divisions among social groups may hinder learning), or within nations (where marginalized groups may not be heard, and where social division and political power influence the development and adaptation agenda). Disaster periods are frequently the times when the development visions and aspirations for the future of those most affected are not recognised. This reflects a widespread limitation on the quality and comprehensiveness of local participation in disaster risk reduction and its integration into everyday development planning. Instead, the humanitarian imperative, limited term reconstruction budgets and an understandable desire for rapid action over deliberation means that too often international social movements and humanitarian NGOs, government agencies and local relief organisations impose their own values and visions, often with the best of intentions. It is also important to recognize the potential for some people or groups to prevent sustainable decisions by employing their veto power or lobbying against reforms or regulations based on short-term political or economic interests (Klein, 2007). The distribution of power in society and who has the responsibility or right to shape the future through decision-making today is thus significant, and includes the role of international as well as national and local actors. Within the international humanitarian community, efforts such as the Sphere Standards and the Humanitarian Accountability Partnership are steps towards addressing this challenge.

Actions to reduce disaster risk and responses to climate change invariably involve trade-offs with other societal goals, and conflicts related to different values and visions for the future. Innovative and successful solutions that combine multiple perspectives, differing worldviews, and contrasting ways of organizing social relations have been



described by Verweij *et al.* (2006) as “clumsy solutions.” Such solutions, they argue, depend on institutions in which all perspectives are heard and responded to, and where the quality of interactions among competing viewpoints foster creative alternatives. Drawing on the development ethics literature, St. Clair (2010) notes that when conflict and broad-based debate is forged, alternatives flourish and many potential spaces for action can be created, tapping into people’s innovation and capacity to cope, adapt and build resilience. Pelling (2010) stresses the importance of social learning for transitional or transformational adaptation, and points out that it requires a high level of trust, a willingness to experiment and accept the possibility of failure in processes of learning and innovation, transparency of values, and active engagement of civil society. Committing to such a learning process is, as Tschakert and Dietrich (2010: 17) argue, preferable to alternatives because “Learning by shock is neither an empowering nor an ethically defensible pathway.”

The conjuncture of hazard and vulnerability, realised through disasters, forces coping and adaptation on individuals and society. Climate change and ongoing development place more people and assets at risk. Noteworthy progress in disaster risk management has been made, especially through the action of early warning on reducing mortality, but underlying vulnerability remains high (as indicated by increasing numbers of people affected and economic losses from disaster) and demographic and economic development trends continue to raise the stakes and present a choice: risk can be denied or faced, and adaptation can be forced or chosen. A reduction in the disaster risks associated with climate and weather extremes is therefore a question of political choice that involves addressing issues of equity, rights and participation at all levels.

### Frequently Asked Questions

#### *FAQ 8.1: What practical steps can we take to move towards a sustainable and resilient future?*

The disruptions caused by disaster events often reveal development failures. They also provide an opportunity for reconsidering development through reconstruction and disaster risk reduction. Practical steps can address both the root causes of risk found in development relations including enhancing human rights, gender equity and environmental integrity, and more proximate causes expressed most commonly through a need for extending land and property rights, access to critical services and basic needs, including social safety nets and insurance mechanisms and transparent decision-making, especially at the local level. Identifying the drivers of hazard and vulnerability in ways that empower both those at risk and risk managers to take action is key. This can be done best where local and scientific knowledge is combined in the generation of risk maps or risk management plans. Greater use of local knowledge when coupled with local capacity can initiate enhanced accountability in integrated risk decision-making that helps to break unsustainable development relations.

The uncertainty that comes with climatic variability and extremes reinforces arguments for better co-ordination and accountability within governance hierarchies and across sectors, as well as between generations and for non-human species in development. Local, national and international actors bring different strengths and tools to questions of environmental change and its relationship to trends in human development. While offering a range of specific practical measures, both local and national approaches to risk management can better meet the flexibility demands of adaptation and resilience when they have strong, accountable leadership, and are enhanced by systematic experimentation and support for innovation in the development of tools as part of planned adaptive risk management approaches. International actors can help by providing an institutional framework to support experimentation, innovation and flexibility. This can be part of national and local strategies to move development away from incentives that promote short-term gain and towards those that promote longer-term sustainability and flexibility.

#### *FAQ 8.2: Why is there not a greater emphasis on technology as the solution to climate extremes?*

Technology is an essential part of responses to climate extremes, at least partly because technology choices and uses are so often a part of the problem. Enhancing early warning systems is one example where technology can play an important role in disaster risk management. This example also flags the importance of considering ‘hard’ (engineering) and ‘soft’ (social and administrative) technology. Great advances have been made in hard technology

around hazard identification, and this has saved many lives. Communicating warnings through the ‘soft’ technology of institutional reform and communication networks has been less well developed. Both hard and soft technology systems must be responsive to different cultures, environments, and types of governance. Most fundamentally, it is clear that technologies are the product of research and development choices, which reflect particular values, interests and priorities. The successful transfer of technology is sensitive to local needs, capacities, and development goals. Technologies can have unintended consequences that contribute to maladaptations. For example, some modern agricultural technologies may reduce local biodiversity and constrain future adaptation. Technologies only matter if they are both appropriate and accessible. Technology development and use are necessary for reducing vulnerabilities to climate extremes, both through mitigation and adaptation, but they need to be the right technologies that are deployed in the right ways. This calls for greater reflection on the social, economic, and environmental consequences of technology across both space and time. In many cases, responses to climate extremes can be improved by addressing social vulnerability, rather than focusing exclusively on technological responses.

**FAQ 8.3: Are transformational changes desirable and even possible, and if so, who will lead them?**

Transformation in and of itself is not always desirable. It is a complex process that involves changes at the personal, cultural, institutional and systems levels. Transformation can imply the loss of the familiar, which can create a sense of disequilibrium and uncertainty. In some cases, notable changes in the nature, form or appearance of a system or process may be inconsistent with the values and preferences of some groups. Transformation can thus be perceived as threatening by some and instrumental by others as the potential for real or perceived winners and losers at different scales stimulates social unease or tension. Desirable or not, it is important to recognize that transformations are now occurring at an unprecedented rate and scale, influenced by globalization, social and technological development, and environmental change. Climate change itself represents a system-scale transformation that will have widespread consequences on ecology and society, including through changes in climate extremes. Responses to climate change and changes in disaster risk can be both incremental and transformational. Transformational responses are not always radical or monumental—sometimes they simply involve a questioning of assumptions or viewing a problem from a new perspective. Transformational responses are not only possible, but they can be facilitated through learning processes, especially reflexive learning that explores blind spots in current thinking and approaches to disaster risk management and climate change adaptation. However, because there are risks and barriers, transformation also calls for leadership—not only from authority figures who hold positions and power, but from individuals and groups who are able to connect present-day actions with their values, and with a collective vision for a sustainable and resilient future. Considering the balance between incremental and transformative adjustments flags the importance of scale. First, because of the opportunities for enhancing leadership capacity that come from greater involvement of those locally at risk or undertaking adaptive experimentation for risk management. Second, because of the potential for transformation, incremental change or stability at one systems level or sector (e.g., administrative, social, technical) to provoke or restrict adjustments in other systems and scales. Inter-scale and inter-sectoral communication therefore becomes an important tool for managing adaptive disaster risk management.

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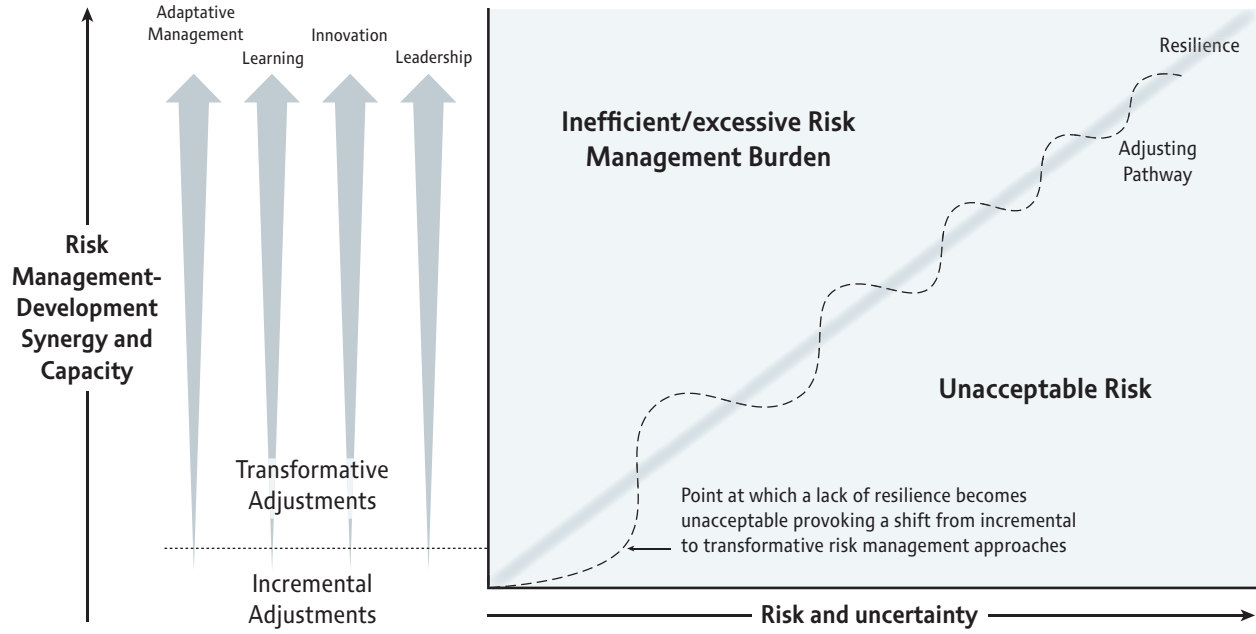


Figure 8-1: Incremental and transformative pathways to resilience.

[Final art to adhere to SREX style guide; production underway.]