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Managing the Risks: International Level and Integration across Scales

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Executive Summary

Increasing global interconnectivity, population, and economic growth, and the mutual interdependence of economic and ecological systems, can serve both to reduce vulnerability and to amplify disaster risks (*high confidence*). Global development pathways are becoming a more important factor in the management of vulnerability and disaster risk. [7.2.1]

The international community has accumulated substantial experience in providing help for disasters and risk management in the context of localized and short-term events associated with climate variability and extremes. Experience in disaster risk management includes both bottom-up and top-down approaches, but most often has developed from disasters considered first as local issues, then at the national level, and only at the international level where needs exceed national capacity, especially in terms of humanitarian assistance and capacity building. [7.2.4]

There are two main mechanisms at the international level that are purpose-built and dedicated to disaster risk management and climate change adaptation. These are the United Nations International Strategy for Disaster Reduction (UNISDR) and the United Nations Framework Convention on Climate Change (UNFCCC), in particular in its adaptation components. This chapter focuses on these two bodies while recognizing that there are many others that have an international role to play. Page limitations require a selective approach and a comprehensive assessment of all relevant bodies is impractical. The UNISDR and the UNFCCC are very different institutions with different mandates and scope and objectives, and with varying strengths and capacities (*high confidence*). Up to the present this fact has made the integration of disaster risk management and climate change adaptation difficult to achieve (*medium confidence*). [7.3] **The evolution of disaster risk management has come from various directions: from the top down where legislation has required safe practice at operational levels and from the local level up to the national and international levels. The evolution of climate change adaptation has been driven primarily by the recognition of the global issue of anthropogenic climate change (*high confidence*).** [7.3]

In addition to the UNISDR and the UNFCCC, other areas of international law and practice are being used to address climate change adaptation and disaster risk management. The relationship between legal aspirations and obligations in these areas of international action and management is complex and neither is well understood or agreed upon (*high confidence*). Other areas include international refugee law, which has been invoked to deal with the displacement of people that might be in part attributed to climate change; human rights law as used by citizens against states for climate change impacting on the enjoyment of human rights; and the attempts to expand existing legal doctrines such as the emerging 'responsibility to protect' doctrine to motive states to act on climate change. Such attempts to use tools from other areas of international law to address climate change adaptation and disaster risk reduction challenges have generally not been successful. [7.2.5]

International action on disaster risk reduction and climate change adaptation can be motivated both by national interests and a concern for the common (global) public good. [7.2] The interdependence of the global economy, the public good, and the transboundary nature of risk management, and the potential of regional risk pooling, can make international cooperation on disaster risk reduction and climate change adaptation more economically efficient than national or sub-national action alone. Notions of solidarity and equity motivate addressing disaster risk reduction and climate change adaptation at the international level in part because developing countries are more vulnerable to physical disasters. [7.2]

Closer integration at the international level of disaster risk reduction and climate change adaptation, and the mainstreaming of both into international development and development assistance, could foster efficiency in the use of available and committed resources and capacity (*high confidence*). [7.4] Neither disaster risk reduction nor climate change adaptation is as well integrated as they could be into current development policies and practices. Both climate change adaptation and disaster risk reduction might benefit from sharing of knowledge and experience in a mutually supportive and synergistic way. Climate change adaptation could be factored into all disaster risk management, and weather-related disasters are becoming an essential component of the adaptation agenda. [7.4]

Opportunities exist to create synergies in international finance for disaster risk management and adaptation to climate change, but these have not yet been fully realized (*high confidence*). International funding for disaster risk reduction remains relatively low as compared to the scale of spending on international humanitarian response. [7.4.2] Governments have committed to mobilize greater amounts of funding for climate change adaptation and this may also help to support the longer-term investments necessary for disaster risk reduction. [7.4.2]

Expanded international financial support for climate change adaptation as specified in the Cancun Agreements of 2010 and the Climate Change Green Fund will facilitate and strengthen disaster risk management (*medium confidence*). The agreements to provide substantial additional finance at the international level for adaptation to climate change have been formulated to include climate- and weather-related disaster risk reduction. There is therefore some prospect that projects and planning for disaster risk reduction and climate change adaptation can increasingly be combined and integrated at the national level (*high confidence*). [7.3.2.2, 7.4]

Technology transfer and cooperation under the United Nations Framework Convention on Climate Change has until recently focused more on the reduction of greenhouse gas emissions than on adaptation (*high confidence*). Technology for disaster risk management, especially to advance and strengthen forecasting and warning systems and emergency response, is promoted through the Hyogo Framework for Action (HFA), but is widely dispersed among many international and national-level organizations and is not closely linked to the UNISDR. Technology transfer and cooperation to advance disaster risk reduction and climate change adaptation are important. Coordination on technology transfer and cooperation between these two fields has been lacking, which has led to fragmented implementation (*high confidence*). [7.4]

International financial institutions, bilateral donors, and other international actors have played a catalytic role in the development of catastrophic risk transfer and other risk-sharing instruments in the more vulnerable countries. **Stronger products and methods for risk sharing and risk transfer are being developed as a relatively new and expanding area of international cooperation to help achieve climate change adaptation and disaster risk reduction (*high confidence*).** [7.4] Established mechanisms include remittances, post-disaster credit, and insurance and reinsurance. Partly in response to concerns about climate change, additional insurance instruments are in various stages of development and expansion including international risk pools and weather index micro-insurance. These processes and products are being developed by international financial institutions as well as by nongovernmental organizations and the private sector. [7.4.4.2]

One lesson from disaster risk reduction and climate change adaptation is that stronger efforts at the international level do not necessarily lead to substantive and rapid results on the ground and at the local level. There is room for improved integration across scales from international to local (*high confidence*). [7.6] The expansion of disaster risk reduction through the International Decade for Natural Disaster Reduction (1990-1999), and the establishment of the UNISDR and the creation and adoption of the HFA have had results that are difficult to specify or to quantify – but which may have contributed to some reduction in morbidity and mortality, while enjoying much less success in the area of economic and property losses. The problems of disaster risk have continued to grow due in large part to the relentless expansion in exposure and vulnerability even as the international management capacity has expanded (*medium confidence*). [7.5, 7.6]

7.1. The International Level of Risk Management

7.1.1. Context and Background

A need to cope with the risks associated with atmospheric processes (floods, droughts, cyclones, and so forth) has always been a fact of human life (Lamb, 1995). In more recent decades, extreme weather events have increasingly come to be associated with large-scale disasters and an increasing level of economic losses (Chapters 2 and 4). Considerable experience has accumulated at the international (as well as local and national) level on ways of coping with or managing the risks.

The same cannot be said for the risks associated with anthropogenic climate change. These are new risks identified as possibilities or probabilities (IPCC 1990, 1996, 2007).

Acceptance of climate change and its growing impacts has led to a stronger emphasis on the need for adaptation, as exemplified, for example, in the Bali Action Plan (adopted at the 13th Session of the Conference of the Parties to the UNFCCC (UNFCCC, 2007a) and the Cancun Agreements of December 2010.

The international community is thus faced with a contrast between a long record of managing disasters and the risks of 'normal' climate extremes, and the new problem of adaptation to anthropogenic climate change and its associated changes in variability and extremes. It has been asked how the comparatively new field of anthropogenic climate change adaptation (CCA) can benefit from the longer experience in disaster risk management (DRM). That question is a major focus of this Special Report.

Climate extremes can have both negative and positive effects. The occurrence of extreme events has raised consciousness of climate change within the public and in policymakers. This can then help to enhance a sense of priority to governmental action in terms of supporting DRM, enhancing adaptation, and promoting mitigation (Adger et al., 2005). An international framework for integration of climate-related DRM and CCA in the development process could provide the potential for reducing exposure and vulnerability (Thomalla et al., 2006; Venton and La Trobe, 2008). Collective efforts at the international level to reduce greenhouse gases are a way to reduce long-term exposure to frequent and more intense climate extremes. International frameworks designed to facilitate adaptation with a deliberate effort to address issues of equity, technology transfer, globalization, and the need to meet the Millennium Development Goals (MDGs) can, when combined with mitigation, lead to reduced vulnerability (Adger et al., 2005; Haines et al., 2006). The 2007/2008 Human Development Report noted that if climate change is not adequately addressed now, 40% of the world's poorest (i.e., 2.6 billion people) will be confined to a future of diminished opportunity (Stern, 2007; Watkins, 2007). The long-term potential to reducing exposure to climate risks lies in sustainable development (O'Brien et al., 2008). Both seek to build resilience through sustainable development (O'Brien et al., 2008).

Some claim that DRM and CCA could be realized through increased awareness and use of synergies and differences, and by the provision of a framework for integration in areas of overlap between the two (Venton and La Trobe, 2008). The World Conference on Disaster Reduction held in Kobe (UNISDR, 2005c), Hyogo Prefecture, Japan in 2005 and the Bali Action Plan both point to the need for incorporation of measures that can reduce climate change impacts within the practice of disaster risk reduction (DRR). Integration of the relevant aspects of DRR and CCA can be facilitated by using the Hyogo Framework for Action (2005-2015) as agreed by 168 governments in Kobe (UNISDR, 2005a).

7.1.2. Related Questions and Chapter Structure

Within the context of the overarching question – how can experience with disaster risk management inform and help with climate change adaptation? – there are a series of other related issues to be addressed in this chapter in order to provide a basis for their closer integration. A first question concerns the rationale for disaster risk management and climate change adaptation at the international level. The issues of systemic risks and international security, economic efficiency, solidarity, and subsidiarity are addressed in Section 7.2.

A second topic concerns the nature and development of institutions and capacity at the international level. This topic is explored in Section 7.3 concentrating on the Hyogo Framework for Action and the United Nations Framework Convention on Climate Change.

A third issue concerns the opportunities for and constraints on disaster risk management and climate change adaptation at the international level. These include the matters of legal, financial, technology, risk transfer, and cooperation, and the creation of knowledge and its management and dissemination. All are addressed in Section 7.4.

Considerations of future policy and research are addressed in Section 7.5.

The challenge of bringing lessons from disaster risk reduction to climate change adaptation takes on a different complexion at different temporal and spatial scales. The question of integration across scales is taken up in Section 7.6.

7.2. Rationale for International Action

This section provides a brief overview of selected concepts and principles that have been invoked to justify (or restrain) financing, assistance, regulation, and other types of international policy interventions for disaster risk management and climate change adaptation. There is no attempt to be comprehensive, and additional principles are discussed in Section 7.2.5. Starting from the reality that risks of extreme weather and risk management interventions cross national borders and transcend single nation policies and procedures, this section discusses the *systemic nature* of these risks and their effects on international security before turning to a discussion of *efficiency, shared responsibility*, and *subsidiarity* as these principles have shaped international discourse, practices, and legal obligations within existing frameworks and conventions.

7.2.1. Systemic Risks and International Security

The term 'systemic risk' refers to risks that are characterized by linkages and interdependencies in a system, where the failure of a single entity or cluster of entities can cause cascading impacts on other interlinked entities. Because of greatly increased international interdependency, shocks occurring in one country can potentially have major and bi-directional systemic impacts on other parts of the world (Kleindorfer, 2009), although the full extent of these impacts is not well documented. Moreover, major interlinked events, such as melting of glaciers, will bring increased levels of hazard to specific areas, and the initial impacts of such changes can extend to second- and third-order impacts (Alexander, 2006). This can apply to the contiguous zones of many countries, such as shared basins with associated flood risks, which calls for transboundary, international mechanisms (Linnerooth-Bayer et al., 2001).

Relationships and connections involving the movement of goods (trade), finance (capital flows and remittances), and people (displaced populations) can also have transboundary impacts as discussed below. Moreover, actions in one country impact another, for example, clearing forests in an upstream riparian country can increase flood risks downstream. Chastened by the unexpected systemic cascading of the 2007-2008 financial crisis, firms with global supply chains are now devoting significant resources to crisis management and disruption risk management (Sheffi, 2005; Harrington and O'Connor, 2009).

A few examples can illustrate the cascading nature of the financial and economic impacts from disaster. Due to Hurricane Katrina in 2005, the International Energy Agency announced a coordinated drawdown of European and Asian oil stocks totaling 60 million barrels (Bamberger and Kumins, 2005), and reportedly oil prices rose not only in the United States but also as far away as Canada and the United Kingdom. Disasters also have an impact on international trade. Using a gravity model across 170 countries (1962-2005), Gassebner et al. (2010) conclude that an additional disaster reduces imports on average by 0.2% and exports by 0.1%. The main conditions determining the impact of disastrous events on trade are the level of democracy and the geographical size of the affected country.

Turning specifically to displaced persons as a cascading impact, estimates of the numbers of current and future migrants due not only to disasters but generally to environmental change are divergent and controversial (Myers, 2001; Christian Aid, 2007). A middle-range estimate puts the figure at 200 million by 2050 (Brown, 2008). Looking only at extreme weather as a cause of migration, a recent report estimates that over 20 million people were displaced due to sudden-onset climate-related disasters in 2008 (OCHA/IDMC, 2009). This report and others, however, acknowledge the difficulty of disentangling the drivers of migration, including climate change risks, rising poverty, spread of infectious diseases, and conflict (Castles, 2002; Myers, 2005; Thomalla et al., 2006; Barnett and Adger 2007; CIENS, 2007; Dun and Gemenne, 2008; Guzmán, 2009; Morrissey, 2009).

As opposed to abrupt displacement due to extreme weather events, mobility and migration can also be an adaptation strategy to gradual climatic change (Barnett and Webber, 2009), which normally leads to slower migration shifts. However, the very poor and vulnerable will in many cases be unable to move (Tacoli, 2009). To the extent that weather extremes contribute to migration, it can result in a huge burden to the destination areas (Barnett and Adger, 2007; Heltberg et al., 2008; Morrissey, 2009; Tacoli, 2009; Warner et al., 2009a). As part of this burden, the conflict potential of migration depends to a significant degree on how the government and people in the transit, destination, or place of return respond. Governance, the degree of political stability, the economy, and whether there is a history of violence are generally important factors (Kolmannskog, 2008).

The international impacts of climate-related disasters can extend beyond financial consequences, international trade, and migration, and affect human security more generally. O'Brien et al. (2008) report on the intricate and systemic linkages between DRR, CCA, and human security, and they emphasize the importance of confronting the societal context, including development levels, governance, inequality, and cultural practices. A further rationale for disaster risk reduction in the face of climate change at the international scale thus places emphasis on ethical issues and the growing connections among people and places in coupled social-ecological systems.

7.2.2. Economic Efficiency

The public policy literature describes situations in which government intervention is justified to address market deficiencies and inefficiencies, a rationale that can also be applied to international interventions. Stern (2007) makes the case that adaptation will not happen autonomously because of inefficiencies in resource allocation brought about by missing and misaligned markets. As a case in point, markets do not allocate resources efficiently in the case of public goods, which are goods that meet two conditions: the consumption of the good by one individual does not reduce availability of the good for consumption by others; and no one can be effectively excluded from using the good. Tompkins and Adger (2005) and Berkhout (2005) discuss how some areas, such as water resources, change from being public to private depending on national regulations and circumstances. Nevertheless, the principles of interdependence and public goods suggested by Stern and others (and which lead to inefficient allocation of resources) are frequently noted in the literature on international responsibility (Stern, 2007; Vernon, 2008; Gupta et al., 2010; World Bank, 2010a).

Early warning systems (as an example of a public good) can depend on regional and international cooperation to make more efficient use of climate data through its exchange. In the field of meteorology, many years of discussion under the auspices of the World Meteorological Organization (WMO) have led to formal agreements on the types of data that are routinely exchanged (WMO, 1995; Basher, 2006). There are similar levels of agreement in other hazard fields, for instance, sharing resources and expertise in managing floods at the river basin scale. As another example of enhanced efficiency through international cooperation, many Caribbean countries have formed a catastrophe insurance pool to reduce reinsurance premiums (see Sections 6.3.3 and 7.4, and Case Study 9.2.13).

7.2.3. Shared Responsibility

It is not only efficiency claims that can be invoked to justify international interventions, but also considerations of shared responsibility and solidarity, especially with those least able to cope with the impacts of extreme events and changes in them due to climate change. This subsection makes reference to selected principles found in the current literature on adaptation to weather-related extremes; there is no attempt to comprehensively assess the moral and ethical literature on this topic.

In the words of the Millennium Declaration that was adopted by 189 nations in September 2000:"We recognize that, in addition to our separate responsibilities to our individual societies, we have a collective responsibility to uphold the principles of human dignity, equality and equity at the global level. Global challenges must be managed in a way that distributes the costs and burdens fairly in accordance with basic principles of equity and social justice. Those who suffer or who benefit least deserve help from those who benefit most" (UNGA, 2000).

In the poorest countries, people have a higher burden in terms of loss of life per event and loss of their assets relative to their income. Based on historical loss data from Munich Re, average fatalities for major disaster events have been approximately 40 times higher in low-income as compared to high-income countries (groupings according to the World Bank), and direct asset losses as a percentage of gross national income have averaged three times greater (Barnett et al., 2008; Linnerooth-Bayer et al., 2010). Changes in frequency, magnitude, and spatial coverage of some climate extremes (see Table 3-1) can result in losses that exceed the capability of many individual countries to manage the risk (Rodriguez et al., 2009). Many have concluded that without significant international assistance the most vulnerable countries will have difficulty in adapting to changes in extreme events and their impacts due to climate change, as well as other impacts of climate change (Agrawala and Fankhauser, 2008; Agrawala and van Aalst, 2008; Klein and Persson, 2008; Klein and Möhner, 2009; Gupta and van de Grijp, 2010; Gupta et al., 2010; World Bank, 2010a). Shared responsibility can take the form of ex-ante interventions to reduce vulnerability and poverty, as well as ex-post disaster response and assistance.

Weather extremes constrain progress toward meeting the MDGs as expressed in the Millennium Declaration, especially the goal of eradicating extreme poverty and hunger (UNDP, 2002; Mirza, 2003; Watkins, 2007; UNISDR, 2009a), which can be interpreted as a direct raison d'être for international intervention in risk management (UNISDR, 2005b; Heltberg et al., 2008). Barrett et al. (2007) have shown that ex-ante risk management strategies on the part of the poor commonly sacrifice expected gains, such as investing in improved seed, to reduce risk of suffering catastrophic loss, a situation perpetuating the 'poverty trap.' The poor can be subject to multiple exposures from climate change and other stresses like geophysical hazards and changing economic conditions (e.g., fluctuating exchange rates) leading to vulnerability to even moderate hazard events (O'Brien and Leichenko, 2000).

Shared responsibility and common human concern have been articulated most effectively with regard to post-disaster humanitarian assistance, and the Millennium Declaration gives specific mention to 'natural' disasters in this context. Section VI (Protecting the Vulnerable) states: "We will spare no effort to ensure that children and all civilian populations that suffer disproportionately the consequences of natural disasters … are given every assistance and protection so that they can resume normal life as soon as possible." With growing globalization the principle of shared responsibility is further enhanced as offers of disaster relief may provide nations access to new spheres of influence both politically and in terms of new business opportunities. Governments can piggyback a humanitarian effort on top of a for-profit operation involving private companies (Dunfee and Hess, 2000).

Disasters can overwhelm the coping mechanisms of nations, in which case international relief and assistance, as a form of solidarity, are required as a matter of saving lives. Humanitarian assistance will remain essential, but emphasizing disaster response strategies at the expense of proactive integrated approaches to disaster risk reduction can have the effect of perpetuating vulnerability (UNDP, 2002; Bhatt, 2007). For this reason, the DRR and CCA communities are placing great emphasis on pre-disaster investment and planning to redress this balance and reduce overall costs of disaster management (Kreimer and Arnold, 2000; Linnerooth-Bayer et al., 2005). These efforts include encouraging the humanitarian community to become a stronger advocate of DRR and CCA.

Beyond a sense of common human concern, it can be argued that countries contributing most to climate change have an obligation to pay to reduce or compensate losses. This is the principle underlying the 'polluter pays principle.' In addition, it can be claimed that countries have a 'principled' obligation to support those who are most vulnerable and who have made a limited contribution to the creation of the climate change problem. This is the claim underlying the expression of 'common but differentiated responsibilities and respective capabilities' (CBDR), which has emerged as one principle of international environmental law (De Lucia, 2007) and has been explicitly formulated in the context of the 1992 Rio Earth Summit (and subsequently in the Preamble and Article 3 of the UNFCCC). "In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command." (Principle 7, the Rio Declaration; UNCED, 1992). The CBDR is discussed further in Section 7.2.5. For purposes here it is important to note that, while the CBDR principle can apply to climate change in general, including incremental change, it is relevant to climate-related disasters only if there is evidence or reason to believe that the disaster would not have occurred or would have been less severe in the absence of climate change.

Another set of literature (e.g., Adger et al., 2009; Caney, 2010) frames equity issues around climate change in terms of 'rights,' namely the right 'not to suffer from dangerous climate change' or 'to avoid dangerous climate change' (Adger, 2004; Caney, 2008). The 'rights' argument, which is highly relevant to international solidarity, can be extended to suggest that individuals and collectives have the right to be protected from risk and disaster imposed by others through the processes that lead to social exclusion, marginality, exposure, and vulnerability. According to this literature, climate change impacts can jeopardize fundamental rights to life and livelihood (such as impacts on disease burden, malnutrition, and food security). Caney (2010, p. 83) also discusses a potential further undeniable right, 'not to be forcibly evicted.' This framing, however, raises a number of difficult issues because of competing fundamental rights (O'Brien et al., 2009).

7.2.4. Subsidiarity

The principle of 'subsidiarity' can be invoked to support a case *against* international intervention. It is best known as articulated in Article 5 of the Treaty of Maastricht on European Union (Maastricht Treaty, 1992). It is based on the concept that centralized governing structures should only take action if deemed more effective or necessary than action at lower levels (Jordan, 2000; Craeynest et al., 2010). The intent is to strengthen accountability and reduce the dangers of making decisions in places remote from their point of application (Gupta and Grubb, 2000). In Europe, the principle of subsidiarity has been interpreted to mean, for example, that international- or national-level involvement in flood protection should only apply to cross-border catchments (Stoiber, 2006). While many regions and river basins are required to develop risk management flood plans, flood protection is considered predominantly a national, and in many countries (e.g., Germany and India), primarily a sub-national (state) responsibility.

The principle also recognizes that multi-level governance requires cooperation between all levels of government (Begg, 2008). As an example of this cooperation, in 2004, the African Union developed a continent-wide African Regional Strategy for Disaster Risk Reduction (African Union, 2010). Below the continental level, disaster management strategies are developed at the regional level (e.g., under the Regional Economic Communities), national level (e.g., National Disaster Management platforms), district level (e.g., District Disaster Management Committees), and local levels (e.g., Village Development Committees). Action at any one level can affect all others in a reflexive fashion.

7.2.5. Legal Obligations

7.2.5.1. Scope of International Law, Managing Risks, and Adaptation

Contemporary international law concerns the coexistence of states in times of war and of peace (19th-century conception of international law, rooted in the Westphalian system), the relationship between a state and citizens (e.g., human rights law), and the cooperation between states and other international actors in order to achieve common goals and address common concerns (e.g., international environmental law). International law, according to the authoritative Article 38 of the Statute of the International Court of Justice, emanates from three primary sources: (1) international conventions, which establish "rules expressly recognized by the … states," and result from a deliberate process of negotiations; (2) international custom, "as evidence of a general practice accepted as law"; and (3) general principles of law, "recognized by civilized nations" (see also Birnie et al., 2009). This triumvirate of conventional and customary international law, and general principles of law, contains legal norms and obligations that can be used to motivate, justify, and facilitate international cooperation on climate change adaptation, such as contained within the UNFCCC, and in anticipation of and response to natural disasters, such as with the emerging field of international disaster relief law.

In addition to international sources of 'hard law,' 'soft law' principles also exist in the form of non-legally binding resolutions, guidelines, codes of conduct (Chinkin, 1989; Bodansky, 2010), and other non-legally binding instruments adopted by states. Collectively, hard law and soft law provide a framework within which states have obligations (hard law) or commitments (soft law) of relevance to adapting to climate change and disaster risk management. These include obligations to mitigate the effects of drought (United Nations Convention to Combat Desertification), to formulate and implement measures to facilitate adaptation (UNFCCC; see Section 7.3.2), to exercise precaution (Rio Declaration), for international cooperation to protect and promote human rights (OHCHR, 2009, para. 84 et seq.), and to develop national legislation to address disaster risk reduction (HFA; see Section 7.3.1).

At the same time as international law appears to provide a normative framework and to create an obligation to "implement … measures to facilitate adequate adaptation to climate change" (UNFCCC Article 4.1(b)), the literature suggests that taken together, international legal instruments are not equipped to fully facilitate climate adaptation and to reduce disaster risk. To illustrate, the law of international disaster response, which aims to establish a legal framework for transborder disaster relief and recovery, has been characterized as "dispersed, with gaps of scope, geographic coverage and precision" (Fisher, 2007), with states being "hesitant to negotiate and accept far-reaching treaties that impose legally binding responsibilities with respect to disaster preparedness, protection, and response" (Fidler, 2005). A second example, international refugee law, does not recognize environmental factors as grounds for granting refugee status to those displaced across borders as a result of environmental factors (Kibreab, 1997).

7.2.5.2. International Conventions

Few internationally negotiated treaties deal, at the international level, with managing risk associated with climate extremes or with adaptation to climate change. As the primary treaty to address climate-related risk management at the international level, the UNFCCC commits Parties to facilitate adequate adaptation, to cooperate with planning for extreme weather, and to consider insurance schemes, though at present it is unresolved as to whether this implies international insurance schemes. Specifically, in Article 4.1(b), Parties to the UNFCCC agree to "formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing … measures to facilitate adequate adaptation to climate change." In Article 4.1(e), Parties agree to "cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods." Article 4.8 of the UNFCCC commits Parties to consider actions "including related to funding, insurance and the transfer of technology" to meet the specific needs and concerns of developing countries. In Article 3.14, UNFCCC's Kyoto Protocol considers the establishment of funding, insurance, and transfer of technology (see also Sections 7.4.2, 7.4.3, and 7.4.4).

In addition to the UNFCCC, Parties to the United Nations Convention to Combat Desertification aim to "combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification … through effective action at all levels, supported by international cooperation and partnership arrangements" (Article 2).

The Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations is the only contemporary multilateral treaty on the topic of disaster relief (Fidler, 2005). Aiming to reduce regulatory barriers for important equipment for disaster response, and entered into force in 2005, the Tampere Convention's first application has been met with limited success, due primarily to limited membership of many of the most vulnerable states (Fisher, 2007).

7.2.5.3. Customary Law and Soft Law Principles

Customary law and soft law principles, unlike international conventions, emerge from informal processes and do not exist in canonical form (Bodansky, 2010, p. 192 et seq.), though such customary law and soft law principles are often reflected in international treaties. This is the reality of various customs and principles that justify or mandate international action on disaster risk reduction and climate change adaptation. To be established as customary law, two elements are requisite: evidence of generally uniform and continuous state practice (regular behavior), and evidence that this practice is motivated by a sense of legal obligation (*opinio juris*) (Bodansky, 1995). Soft law principles of law, by contrast, are not customary norms and do not reflect behavioral regularities. They are rather an articulation of collective aspiration, important in shaping the "development of international law and negotiations to develop more precise norms" (Bodansky, 2010, p. 200). In practice, the distinction between rules of customary law (reflecting actual practice of states following a legal obligation) and soft law principles is frequently blurred. For instance, the principle of common but differentiated responsibilities and respective capabilities – which would for example suggest that states have differentiated responsibilities in addressing disaster risk and financing adaptation – is increasingly supported by state practice, however *opinio juris* is lacking as it is unclear whether most states consider the principle to be a legal obligation. The principle of common but differentiated responsibilities and respective capabilities might thus fall closer to a general principle than a customary norm. Irrespective of this status, the principle of common but differentiated responsibilities and respective capabilities is nevertheless a principle that states may apply in their international relations, even if it is not a norm of customary international law.

The precautionary principle states that scientific uncertainty does not justify inaction with respect to environmental risks (Trouwborst, 2002), and is articulated in a number of international instruments including Principle 15 of the Rio Declaration, and Article 3 of the UNFCCC. That states have a duty to prevent transboundary harm, provide notice of, and undertake consultations with respect to such potential harms is a soft law norm expressed under international environmental law. The more general duty to cooperate has evolved as a result of the inapplicability of the law of state responsibility to problems of multilateral concern, such as global environmental challenges. The Office of the High Commissioner for Human Rights has noted that "climate change can only be effectively addressed through cooperation of all members of the international community" (OHCHR, 2009). From the duty to cooperate is deduced a duty to notify other states of potential environmental harm. This is reflected in Principles 18 and 19 of the Rio Declaration (a non-legal international instrument), that "States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States" (Rio Principle 18) and "States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect" (Rio Principle 19).

7.2.5.4. Non-Legally Binding Instruments

Many international instruments are non-legal in nature (Raustiala, 2005). This is the case with respect to disaster relief where many of the most significant international instruments are non-binding. Illustrative are the Code of Conduct for the International Red Cross and Red Crescent Movement and Nongovernmental Organizations in Disaster Relief (ICRC, 1995) and the Sphere Project, Humanitarian Charter and Minimum Standards in Disaster Response (Sphere Project, 2004), which focus on the quality of relief developed by the international humanitarian community. These are limited by lack of compliance mechanisms (Fidler, 2005), as well as in their application, as they are the creation of international nongovernmental organizations (NGOs) and are rarely recognized in the policies of national governments. The Guiding Principles on Internal Displacement (Cohen, 1998) articulate principles of disaster prevention and of human vulnerability (Fisher, 2007).

International human rights norms as articulated in the International Bill of Human Rights have also been applied to disaster risk reduction and adaptation to climate change. Notably, the Report of the Office of the High Commission for Human Rights observes that climate change and response measures thereto can have a negative effect on the realization of human rights including rights to life, adequate food, water, health, adequate housing, and self-determination (OHCHR, 2009). These rights could risk being jeopardized when contemplated, for example, in the context of migration induced by extreme weather events. As discussed in Section 7.3.1, the HFA further stipulates key tasks for governments and multi-stakeholder actors; among these is the development of legal frameworks (UNISDR, 2005a, para. 22). The HFA is an international framework, a priority area of which is to ensure that disaster risk reduction is a national priority with an institutional basis for implementation. As to adaptation, the Bali Action Plan agreed to at the 13th Conference of the Parties to the UNFCCC recognizes the need to address consideration of disaster reduction strategies and risk management within adaptation (UNFCCC, 2007a). Adaptation is further addressed in the Cancun Agreements (UNFCCC, 2010c).

7.3. Current International Governance and Institutions

Among the many relevant frameworks and protocols administered by a host of United Nations and other international agencies, the most significant for this Special Report are the HFA, to reduce disaster risk, and the UNFCCC, which includes adaptation to the adverse effects of climate change. Since both DRR and CCA occur within a broader development context and are particularly relevant to the challenges facing developing countries, they are indirectly connected to a third important international framework: the MDGs.

The UNFCCC was adopted in 1992 following one year of negotiations and was further complemented by the Kyoto Protocol adopted in 1997. The Convention came into force in 1994 and the Protocol in 2005. In parallel, the DRR framework was adopted as a nonbinding instrument in 2005 following two years of negotiations and is time bound – 2005 to 2015. The HFA recognizes the relevance of addressing climate change in order to reduce the risk of disasters and, as soon as adopted, the two processes began to work together, collaborating closely in order to synchronize frameworks and approaches so as to create added value to current risk management initiatives. This IPCC Special Report is one example of the initiatives taken by governments. It is one of the first official products of the two communities working within different but related policy frameworks.

This section first introduces the HFA and the UNFCCC, including an overview of their respective objectives, legal nature, and status of implementation. It then presents relevant international actors involved in implementing these two frameworks, as well as a summary of other relevant international policy frameworks and agencies.

7.3.1. The Hyogo Framework for Action

7.3.1.1. Evolution and Description

The first major collective international attempt to reduce disaster impact, particularly within hazard-prone developing countries, took place in 1989, when the United Nations (UN) General Assembly designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) (Wisner et al., 2004). About 120 National Committees were established and in 1994, the first World Conference on Natural Disaster Reduction was held in Yokohama, Japan. The conference produced the 'Yokohama Strategy and Plan of Action,' providing policy guidance with a strong technical and scientific focus.

In 2000, the IDNDR was followed by the United Nations International Strategy for Disaster Reduction (UNISDR), which broadened the technical and policy scope of the IDNDR to include increased social action, public commitment, and linkages to sustainable development. The UNISDR system promotes tools and methods to reduce disaster risk while encouraging collaboration between disaster reduction and climate change. The UNISDR Secretariat provides information and guidance on disaster risk reduction and has increasingly widened its focus to embrace adaptation to climate change. The strategy undertakes global reviews of disaster risk and promotes national initiatives to reduce disaster risk. The UNISDR has also promoted the development of National Platforms. A key function is to assist in the compilation, exchange, analysis, and dissemination of good practices and lessons learned in disaster risk reduction (refer to Section 7.4.5).

In January 2005, just three weeks after the Indian Ocean tsunami, the second World Conference on Disaster Reduction was held in Kobe, Japan. 168 governments adopted the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. The adoption of the framework directly after a devastating tsunami gave the framework high visibility in many countries. The HFA was unanimously endorsed by the UN General Assembly (UNISDR, 2005a). The HFA is not a binding agreement: the governments simply agreed and adopted the framework as a set of recommendations to be utilized voluntarily. In international law it can be described as 'soft law.' Some regard the voluntary nature of the HFA as a useful flexible commitment, largely based on self-regulation and trust, while others regard this as its inherent weakness (Pelling, 2011, p. 44).

The HFA's Strategic Goals include the integration of DRR into sustainable development policies and planning; development and strengthening of institutions, mechanisms, and capacities to build resilience to hazards; and the systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response, and recovery programs (UNISDR, 2005a). The Framework also provides five Priorities for Action:

1) Ensure that DRR is a national and local priority, with a strong institutional basis for implementation
2) Identify, assess, and monitor disaster risks, and enhance early warning
3) Use knowledge, innovation, and education to build a culture of safety and resilience at all levels
4) Reduce the underlying risk factors
5) Strengthen disaster preparedness for effective response at all levels.

The priorities address all hazards with a multi-hazard approach, hence the inclusion of climate change risks and adaptation, but they do not specify the need to factor climate change risks and adaptation into ongoing action. The HFA does identify 'critical tasks' for varied actors, including states who are to "promote the integration of DRR with climate variability and climate change into DRR strategies and adaptation to climate change" (UNISDR 2005a; see also UNISDR, 2009a, 2011a,b; World Bank, 2011a).

7.3.1.2. Status of Implementation

This section will review the various tools that have been used to measure the performance of the HFA in fulfilling its Strategic Goals and Priorities for Action.

The measurement of performance in the implementation of DRR was a matter of considerable debate when the HFA was drafted. The consensus was for the final text not to include targets or indicators of progress, but countries were encouraged to develop their own guidelines to monitor their own progress in reducing their risks. To assist this process, in 2008, UNISDR published guidance notes on 'Indicators of Progress' (UNISDR, 2008). This provided the template for self-assessment that is used in national reports. While there is an obvious value in 'self-assessment' as a learning experience, in the absence of external, objective evaluation, inevitable doubts will always remain concerning such internal reporting on actual progress with DRR and CCA.

The main instruments to encourage HFA applications are the HFA Monitoring Service on PreventionWeb acting mainly as a guidance tool for countries to monitor their own progress in DRR. This is a multi-tier online tool for regional, national, and local progress review. Core Indicators are measured for the five HFA Priorities for Action as noted below, and these are reported with detailed analysis in the Global Assessment Reports (UNISDR, 2009a, 2011a; refer to Section 7.4.5). In addition to these biennial reports, the UNISDR has published a mid-term review of progress in achieving the HFA (UNISDR, 2011b). Further tools to measure progress include the reports to the biennial sessions of the Global Platform for DRR and the regional platforms for DRR and other similar mechanisms. The World Bank and the United Nations Development Programme (UNDP) also utilize the HFA to guide their support to national and local programs on DRR and gradually also for CCA (the HFA is also discussed in Sections 1.3.6 and 6.3.2).

As a result of the adoption of HFA, and the development of performance indicators, global efforts to address DRR have become more systematic. In 2009, the first biennial Global Assessment Report (GAR) on Disaster Risk Reduction was released and in the same year the Global Network of Civil Society Organisations for Disaster Reduction (GNDR) also released a report on the performance of the HFA (GNDR, 2009). The GAR found that since the adoption of the HFA, progress toward decreasing disaster risk is varied across scales. This variation is based on national government agencies self-assessment of progress against the indicators defined by the UNISDR (UNISDR, 2008) and since many of these indicators require a subjective assessment, progress is not directly comparable across countries.

Countries have been making improvements toward increasing capacity, developing institutional systems, and legislation to promote DRR, and early warning systems have been implemented in many areas. However, the Global Assessment Reports (UNISDR, 2009a, 2011a) conclude that progress is still required to mainstream DRR into public investment, development planning, and governance arrangements. During 2010, at the mid-point in the HFA, the UN Secretary General echoed this concern in reporting that "risk reduction is still not hardwired into the 'business processes' of the development sectors, planning ministries and financial institutions" (UNGA, 2010, p. 5).

Further, both the GARs and the GNDR (2009, 2011) noted that at national and international levels, policy and institutional frameworks for climate change adaptation and poverty reduction are not yet synchronized to those for DRR. For example, the 2011 GAR reports on weak coordination and separate management between institutional and program mechanisms (UNISDR, 2011a, p. 150).

The GNDR observed that ecosystem management approaches can provide multiple benefits, including risk reduction, and thus be a central part of DRR strategies. But countries have experienced difficulty in addressing underlying risk drivers (such as food security, social protection, building codes/standards, poverty alleviation, poor urban and local governance, vulnerable rural livelihoods, and ecosystem decline) in a way that leads to a reduction in the risk of damages and economic loss (GNDR, 2009). This Fourth HFA Priority for Action – 'Reduce the Underlying Risk Factors' – remains the greatest challenge to civil society bodies, with all 13 criteria only reaching a rating of 2 on the assessment scale: 'some activity but significant scope for improvements' (GNDR, 2009, pp. 24–26). The

GARs also note this area of weakness, but note that it is possible for countries to address underlying risk drivers using an assortment of mechanisms to increase resilience (e.g., raising awareness, education, training, risk assessments, early warning systems, building safety, micro-insurance in macro-financing schemes) (UNISDR, 2009a, 2011a).

It was also acknowledged in the 2009 GAR that weather-related disaster risk is escalating swiftly, in terms of the regions affected, frequency of events, and losses reported. This frequency relates to occurrence patterns as well as improved reporting of all categories of weather-related hazards. Data was collected from a sample of 12 Asian and Latin American countries: Argentina, Bolivia, Colombia, Costa Rica, Ecuador, the Indian states of Orissa and Tamil Nadu, Iran, Mexico, Nepal, Peru, Sri Lanka, and Venezuela. The report further noted that these increases will magnify the uneven distribution of risk between wealthier and poorer countries (UNISDR, 2009a, p. 11). Furthermore, a conclusion is drawn in the report that climate change is changing the geographical distribution, intensity, and frequency of these weather-related hazards, threatening to exceed the capacities of poorer countries and their communities' abilities to absorb losses and recover from disaster impacts (UNISDR, 2009b). However, the 2011 GAR reported significant progress with a decrease in global mortality risk from tropical cyclones and flooding, with the only exception being South Asia where vulnerability is still increasing (UNISDR, 2011a, p. 28).

The 2009 and 2011 GARs, as well as the discussion they generated in the Global Platforms of 2009, have brought a regional dimension to performance assessment, in an effort to monitor progress.

When evaluating the progress of HFA on each of its five Priorities for Action, the GNDR found that the lowest level of progress across all the five priorities was at the lowest scale in community participation in decisionmaking on DRR (GNDR, 2009). These findings also indicate the need for a stronger link between policy formulation at international and national levels to policy execution at local levels. Rapid progress has been made in the development of comprehensive seasonal and long-term early warning systems (EWS) to anticipate droughts, floods, and tropical storms. These systems have proved to be effective in saving lives and protecting property. In the 2009 GAR, the status of EWS was reviewed (UNISDR, 2009a, Box 5.2 on p. 127). This was based on a detailed progress review of EWS undertaken by WMO (WMO, 2009). Typical examples of the effectiveness of EWS in reducing the impact of cyclones and flooding can be found in Mozambique, where their EWS was first tested in a cyclone in 2007 (Foley, 2007) and in Bangladesh, where the flood and cyclone EWS has been progressively developed over three decades (Paul et al., 2010; also see Case Study 9.2.11).

A key finding concerned the importance of education and sharing knowledge, including indigenous and traditional knowledge, and ensuring easy and systematic access to best practice tools and international standards, tailored to specific sectors (see Section 7.4.5). There is some recognition of the benefits in harmonizing and linking the frameworks and policies for DRM and CCA as core policy and programmatic objectives in national development plans and in support of poverty reduction strategies. DRM policies also need to take account of climate change. Nevertheless, countries are making significant progress in strengthening capacities, institutional systems, and legislation to address deficiencies in disaster preparedness and response (GNDR, 2009; UNISDR, 2009a).

In preparing for the mid-term review of the HFA, the UNISDR secretariat commissioned a desk review of literature to form "a baseline of the disaster risk reduction landscape." Forty-seven key documents were identified, mainly consisting of reports from UNISDR offices and partner organizations: NGOs and international development banks (UNISDR, 2011b).

The HFA Mid-Term Review 2010-2011 raised two important international issues. The first need is to develop accountability mechanisms at all levels to measure the actions taken and progress achieved in DRR. The second need is for the international community to develop a more coherent and integrated approach to support the implementation of the HFA. The review suggests that this will require connected action of the varied international actors (UNISDR, 2011b).

However, it is important to reflect on the reality that all of these methods to review international progress in risk reduction – country progress reports, the 2009 and 2011 GARs, the reports of the GNDR, and the Mid-Term Review of the HFA – are all internally produced reports by the participating agencies with external advisory boards and peer review, but all involving self-assessment. The GNDR's publications are fully independent from the UN and governments, but make no claim to be scientifically accurate assessments. The country HFA reports are online at www.preventionweb.net/english/hyogo/progress/?pid:73&pih:2.

All the above studies attempted to assess HFA performance and, as noted above, none were totally separate from the work or institutions being assessed. Furthermore, none looked specifically at the performance of the lead organization, UNISDR, in comparison with other multilateral bodies. This report came in 2011, when the UK Aid Agency, the Department for International Development (DFID), published a Multilateral Aid Review. The purpose was to ensure maximum value for money for UK aid by examining the performance of 43 multilateral organizations. This peer-reviewed assessment placed the UNISDR in a 43rd-ranked position in an assessment of 43 multilateral organizations (DFID, 2011).

This independent and comparative assessment included an evaluation of UNISDR since its foundation and identified its strength as global coordinator of the three Global Platforms in DRR that have been successful in advocacy and raising awareness. However, the assessment also identified a series of shortcomings in UNISDR. They included its poor performance in international coordination and its focus on national-level responses rather than its global mandate, which is broad rather than specific in focus. Further criticisms include inadequate attention to strategic considerations as well as leadership failures, with the report stating that there was no clear line of sight from UNISDR's mandate, to a strategy, to an implementation plan and that there was an absence of a results-based framework, thus making it difficult to measure results from input to output (DFID, 2011, p. 211).

UNISDR responded to the assessment by noting that the criticisms were also reflected in a UN audit as well as in an external evaluation requested by UNISDR in 2009, and that changes had now been incorporated in a management-reform work program (UNISDR, 2011c).

Whatever method is adopted to monitor progress with risk reduction and climate change adaptation (internal or external, self-assessment or peer review), the implicit problems faced in the measurement of DRR and CCA before a disaster event must be recognized. It is not easy, even with detailed objective scientific measurement, to accurately determine whether a given structural or non-structural measure will actually provide the necessary level of protection to people and property under extreme hazard loads. Structural tests can be carried out and simulation exercises can be usefully conducted to test warning systems or the effectiveness of preparedness, but at best such performance tests can only approximate disaster reality. The ultimate test of DRR and CCA applications will inevitably need to await the impact of the next disaster. But this limitation does not remove the requirement to monitor and measure progress in an objective scientific manner to the upper limits of existing knowledge (Davis, 2004).

7.3.2. The United Nations Framework Convention on Climate Change

7.3.2.1. Evolution and Description

The UNFCCC is a multilateral treaty aimed at addressing climate change. Its ultimate objective as stated in Article 2 is (UN, 1992; see also Oppenheimer and Petsonk, 2005):

> "to achieve … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

The UNFCCC was negotiated from February 1991 to May 1992, and opened for signature at the UN Conference on Environment and Development in Rio de Janeiro in June 1992. It entered into force on 21 March 1994, and since 1995 the Conference of the Parties (COP) to the UNFCCC has met in yearly sessions. The rules, institutions, and procedures of the UNFCCC have been described in detail elsewhere (e.g., Yamin and Depledge, 2004; Bodansky, 2005). The development of adaptation as a priority under the UNFCCC has been analyzed by Schipper (2006).

A major thrust of the UNFCCC and subsequent negotiations about its implementation concerns the mitigation of climate change: all policies and measures aimed at reducing the emission of greenhouse gases such as carbon dioxide (CO_2), or at retaining and capturing them in sinks such as forests, oceans, and underground reservoirs. As mentioned by Schipper (2006), adaptation to climate change was initially given little priority, although it is subject to various commitments in the UNFCCC (see Box 7-1). When taken together, these commitments acknowledge the systematic nature of climate change risks and the relevance of the principles of economic efficiency, solidarity, and subsidiarity in adaptation.

The Kyoto Protocol, agreed at COP3 in 1997 and in force since 2005, sets binding targets for 37 industrialized countries and the European Union for reducing greenhouse gas emissions by an average of 5% compared to 1990 over the five year period 2008-2012. Adaptation is all but absent in the Kyoto Protocol, with two exceptions. Article 10(b) specifies that Parties shall formulate, implement, publish, and regularly update national and, where appropriate, regional programs containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change. Article 12.8, on the Clean Development Mechanism, provides the basis of what later became the Adaptation Fund (see Section 7.4.2).

7.3.2.2. Status of Implementation

There is to date no overall assessment of progress on adaptation under the UNFCCC in the way that the UNISDR has assessed progress under the HFA in the GARs. However, Parties to the UNFCCC are required to submit National Communications on their activities toward implementing the UNFCCC, including adaptation. There is no common reporting template so reports vary widely in content, making aggregation or comparison problematic. The annual sessions of the COP also allow countries to assess their progress toward meeting their commitments under the UNFCCC, and to negotiate and adopt new decisions for further implementation. By June 2011, there were 195 Parties to the UNFCCC: 194 countries and one regional economic integration organization (the European Union).

During the 1990s, adaptation received little attention in the UNFCCC negotiations, reflecting a similarly low level of attention to adaptation from the academic community at the time (Burton et al., 2002). The profile was raised in 2001 with the publication of the IPCC Third Assessment Report, which contained the chapter 'Adaptation to Climate Change in the Context of Sustainable Development and Equity' (Smit et al., 2001). Also in 2001, COP7 adopted a decision (5/CP.7) that outlined a range of activities that would promote adaptation in developing countries, including the preparation of National Adaptation Programmes of Action (NAPAs) by least-developed countries. To this end, COP7 established three funds with which adaptation in developing countries could be supported, namely the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF), and the Strategic Priority 'Piloting an Operational Approach to Adaptation' (SPA) under the Trust Fund of the Global Environment Facility (GEF). In addition, COP7 took the first steps toward making operational the Adaptation Fund (Huq, 2002;

Box 7-1 | Commitments on Climate Change Adaptation as Included in the UNFCCC

Article 4.1: All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives, and circumstances, shall:

(b) Formulate, implement, publish, and regularly update national and, where appropriate, regional programs containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change.

(e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources, and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods.

(f) Take climate change considerations into account, to the extent feasible, in their relevant social, economic, and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health, and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change.

Article 4.4: The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

Article 4.8: In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance, and the transfer of technology, to meet the specific needs and concerns of developing country Parties […].

Article 4.9: The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology.

Dessai, 2003; Mace, 2005). Section 7.4.2 provides more information on the international financing of climate change adaptation.

Since 2001, a number of successive decisions have given increasing priority to climate change adaptation under the UNFCCC. Decision 1/CP.10 built on Decision 5/CP.7; it reiterated the need for support for adaptation in developing countries and started a regional consultation process. Decision 2/CP.11 then established the Nairobi Work Programme on impacts, vulnerability, and adaptation to climate change, which originally ran from 2006 to 2010 – a next phase is currently under consideration, to be decided at COP17 in Durban in 2011. The objective of the Nairobi Work Programme is to assist all Parties, in particular developing countries, (i) to improve their understanding and assessment of impacts, vulnerability, and adaptation to climate change, and (ii) to make informed decisions on practical adaptation actions and measures to respond to climate change on a sound scientific, technical, and socioeconomic basis, taking into account current and future climate change and variability (Decision 2/CP.11). The Nairobi Work Programme is implemented by Parties, intergovernmental and nongovernmental organizations, the private sector, communities, and other stakeholders. Several of the nine work areas of the Nairobi Work Programme are relevant to DRR as well as CCA, in particular 'climate-related risks and extreme events' and 'adaptation planning and practices.'

With Decision 1/CP.13 (also known as the Bali Action Plan), agreed in December 2007, the COP launched "a comprehensive process to enable the full, effective, and sustained implementation of the Convention through long-term cooperative action – now, up to, and beyond 2012 – in order to reach an agreed outcome and adopt a decision at its fifteenth session" in Copenhagen in December 2009 (COP15). The Bali Action Plan gave equal priority to mitigation and adaptation, and identified technology and finance as the key mechanisms for enabling developing countries to respond to climate change (Clémençon, 2008; Ott et al., 2008; Persson et al., 2009). It recognized the need for action to enhance adaptation in five main areas:

1) International cooperation to support urgent implementation of adaptation actions, including through vulnerability assessments, prioritization of actions, financial needs assessments, capacity building, and response strategies, and integration of adaptation actions into sectoral and national planning […]
2) Risk management and risk reduction strategies, including risk-sharing and transfer mechanisms such as insurance
3) Disaster reduction strategies and means to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change
4) Economic diversification to build resilience
5) Ways to strengthen the catalytic role of the Convention in encouraging multilateral bodies, the public and private sectors, and civil society, building on synergies among activities and processes, as a means to support adaptation in a coherent and integrated manner.

No agreed outcome was reached at COP15, and no comprehensive decision was adopted that included these five issues. Instead, the COP decided to take note of the Copenhagen Accord, a nonbinding document about which there was no consensus among Parties, and which provides considerably less substance on adaptation than the Bali Action Plan (Bodansky, 2010; Grubb, 2010; Klein, 2010). As mentioned in Section 7.4.2, however, the Copenhagen Accord was a milestone toward scaled-up funding for both mitigation and adaptation.

In 2010, Decision 1/CP.16 (part of the Cancun Agreements) established the Cancun Adaptation Framework (Cozier, 2011). It invites all Parties to enhance action on adaptation by undertaking nine activities related to planning, implementation, capacity strengthening, and knowledge development, including "enhancing climate change related disaster risk reduction strategies, taking into consideration the Hyogo Framework for Action where appropriate; early warning systems; risk assessment and management; and sharing and transfer mechanisms such as insurance, at local, national, sub-regional, and regional levels, as appropriate." In addition, Decision 1/CP.16 established (i) a process to enable least-developed countries and other developing countries to formulate and implement national adaptation plans; (ii) an Adaptation Committee that will, among other things, provide technical support, share relevant information, promote synergies, and make recommendations on finance, technology, and capacity building required for further action; and (iii) a work program in order to consider approaches to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change.

Decision 1/CP.16 also established a Technology Mechanism, consisting of a Technology Executive Committee and a Climate Technology Center and Network. The Technology Mechanism should accelerate action at different stages of the technology cycle, including research and development, demonstration, deployment, diffusion, and transfer of technology in support of mitigation and adaptation. Finally, Decision 1/CP.16 established the Green Climate Fund as a new entity operating the financial mechanism of the UNFCCC under Article 11 (see Section 7.4.2).

The unfolding of international adaptation policy under the UNFCCC shows the increasing prominence of adaptation in the negotiations, and the increasing level of detail and concreteness of the relevant COP decisions. It also shows that adaptation under the UNFCCC is increasingly linked with disaster risk reduction, with the Hyogo Framework for Action explicitly mentioned in the Cancun Agreements. Yet, this unfolding, from Decision 5/CP.7 to Decision 1/CP.16, has taken 10 years.

7.3.3. Current Actors

A wide range of actors play a role in DRM and CCA at the international level. This section does not attempt a comprehensive review of all of these, but instead identifies the broad areas in which the international community is providing support at the interface between DRM and CCA, describes some of the main actors under each of these categories, and summarizes, where available, independent assessments of their strengths and weaknesses in performing these roles.

7.3.3.1. International Coordination in Linking Disaster Risk Management and Climate Change Adaptation

Given the wide range of actions and actors that are considered necessary by those involved to carry out DRM and CCA, and to link them to each other, effective international coordination is essential. Overall, there are weaknesses in the current systems; the 2009 Global Assessment Report on Disaster Risk Reduction states that: "Efforts to reduce disaster risk, reduce poverty and adapt to climate change are poorly coordinated" (UNISDR, 2009a).

The main coordination mechanism for DRR, contributing to DRM, is the UNISDR, designed to develop a system of partnerships to support nations and communities to reduce disaster risk. These partners include governments, intergovernmental and nongovernmental organizations, international financial institutions, scientific and technical bodies and specialized networks as well as civil society and the private sector. Among the diverse range of stakeholders across scales, the national governments play the most important roles, including developing national coordination mechanisms; conducting baseline assessments on the status of disaster risk reduction; publishing and updating summaries of national programs; reviewing national progress toward achieving the objectives and priorities of the Hyogo Framework; working to implement relevant international legal instruments; and integrating disaster risk reduction with climate change strategies. Intergovernmental organizations play a supporting role, including, for example, promotion of DRR programs and integration into development planning, and capacity building (UNISDR, 2005b). The fact that the primary roles in planning and implementation are played by national governments, while the UNISDR Secretariat and other intergovernmental organizations provide supporting, monitoring, and information sharing roles at the regional and global level is consistent with the principle of subsidiarity.

UNISDR has made specific efforts to link DRR and CCA, through advocacy of the role of DRR in climate change adaptation, and support for scientific reviews of the linkages (including this report). Two evaluations covering the effectiveness of UNISDR in linking DRR and CCA have recently been published. The UN Special Representative of the Secretary-General for Disaster Risk Reduction and the main donors to UNISDR requested an independent evaluation of the performance of the secretariat, which was published in 2010 (Dalberg, 2010). This review endorsed the overall effectiveness of UNISDR, particularly in advocacy and awareness raising, and in establishing global and regional platforms, and specifically highlights its strong contribution to mainstreaming DRR into climate change policy. However, it also highlights difficulties, including lack of definition of comparative advantage within CCA implementation, and the need to balance the focus and resources spent on DRR in climate change adaptation versus the broader DRR concept. The same review also illustrates challenges in coordination of implementation, particularly the need for effective coordination with UN Country Teams, the World Bank, and other relevant partners at the country level, and in the full implementation and sustainable follow-up of new initiatives. The UK Government also published a review of the performance of the UNISDR Secretariat, alongside other multilateral agencies, in 2011 (DFID, 2011). The review is critical of the overall operational and organizational strengths of the UNISDR, citing a lack of a results-based framework, and weaknesses in strategic direction, coordination focus, and speed of reform. The review does, however, highlight the unique coordinating role of UNISDR, and specifically praises "a good focus on climate change, especially adaptation."

From the CCA side, the main global mechanism to increase understanding and share best practice in CCA is the Nairobi Work Programme (NWP), coordinated by the UNFCCC Secretariat (UNFCCC, 2010a; refer to Section 7.3.2.2). The NWP functions mainly as a forum for interested parties and organizations to specify their own contributions to CCA through 'action pledges,' and for sharing, synthesis, and dissemination of information. Disaster risk reduction is well represented within the NWP, which identifies DRR as one of its 14 specified adaptation delivery activities, with an associated 'call to action' for strengthened work in areas such as linking DRR and CCA, risk mapping, and cost-benefit analysis of adaptation options. Out of the 137 action pledges made by partners, 59 include a component of DRR. Evaluation of the NWP by Parties is only now being carried out, so as yet there is no formal assessment of the degree to which it has supported changes in policy and practice as well as information exchange.

7.3.3.2. International Technical and Operational Support

DRM and CCA are now beginning to be linked not only in international coordination activities, but also in mechanisms for international technical and operational support.

7.3.3.2.1. Climate services for disaster risk reduction and climate change adaptation

National meteorological and hydrological services (NMHSs) are the primary source of meteorological observations and forecasts at time scales relevant to both disaster risk management and climate change adaptation. These national services also constitute the members of the WMO, which serves to set international standards and coordinate among the members, as well as supporting several relevant international programs, including a Disaster Risk Reduction and Service Delivery Branch and a Climate Prediction and Adaptation Branch.

In recent years, a number of studies have identified weaknesses in the way in which the large amount of potentially relevant information that is available from NMHSs at the national and international level is incorporated into development decisions, particularly in the most vulnerable countries. For example a 'gap analysis' of this issue in Africa identified gaps in (i) integrating climate into policy; (ii) integrating climate into practice; (iii) climate services; and (iv) climate data, concluding that "the problem is one of 'market' atrophy: negligible demand coupled with inadequate supply of climate services for development decisions" (IRI, 2006). Studies on specific sectors (e.g., health: Kuhn et al., 2005), or at a local level (Vogel and O'Brien, 2006), conclude that the main deficit is not in generation of data, but in knowledge management. They conclude that this requires more effective mechanisms for decisionmakers to identify their information needs, and to work both with providers of weather and climate information and with institutions working on other dimensions of human and social vulnerability to address these needs.

In response to the need for a comprehensive approach to climate variability and change, and the drive for more demand-driven climate services the, World Climate Conference-3 agreed in 2009 to begin development of a Global Framework on Climate Services (GFCS) (WMO, 2010). This has a goal of "the development and provision of relevant science-based climate information and prediction for climate risk management and adaptation to climate variability and change, throughout the world." The framework therefore explicitly links climate variability (most relevant to DRR), in the context of climate change (most relevant to CCA), and support for risk management decisions (common to both). The GFCS has four major components: a User Interaction Mechanism; a World Climate Services System; Climate Research; and Observation and Monitoring. The initiative will focus on improving access and operational use of climate information, especially in vulnerable, developing countries. The principles and focus of the initiative therefore correspond closely to the objectives of linking DRM and CCA in operational planning across international and smaller scales. In May 2011, the 16th WMO congress committed to "support and facilitate the implementation of the GFCS as a priority of the Organization," including the development of an implementation plan for review and adoption in 2012 (WMO, 2011).

7.3.3.2.2. Technical and operational support from civil society

Some of the largest international civil society organizations involved in disaster risk management and humanitarian response are now beginning to integrate climate change adaptation activities into their operational programs (e.g., CARE International, 2010; Oxfam, 2011). One of the longest established examples of civil society providing technical support to CCA and DRM integration is the Red Cross/Red Crescent Climate Centre. Alongside awareness raising and advocacy, the Centre analyzes forecast information and integrates knowledge of climate risks into Red Cross/Red Crescent strategies, plans, and activities, with a particular focus on implementation at the community level (IFRC, 2011).

The various international civil society organizations working on DRR are now also beginning to coordinate their operational support, and to make explicit links to CCA (UNISDR, 2009a). The GNDR was launched in 2007, and constitutes over 300 organizations across 90 countries. It

Box 7-2 | Disaster Risk Management and Climate Change Adaptation in the Context of International Development

Vulnerability to extreme weather and to climate change is strongly conditioned by socioeconomic development, including income levels and distribution, supportive institutional frameworks, and the capacities of specific sectors. Conversely, the effects of climate change, including through any increase in the frequency of extreme weather events, can also set back economic development (Stern, 2007). Countries that are relatively poor, isolated, and reliant on a narrow range of economic activities are particularly vulnerable to such shocks (UNISDR, 2009a). The objectives of climate change adaptation, disaster risk reduction, and sustainable development are therefore intricately linked, and while the HFA and UNFCCC are the main international frameworks for CCA and DRR, a wider range of other governance and institutional mechanisms have a major influence. These range, for example, from the agreements of the World Trade Organization (affecting development and potentially technology transfer for adaptation; WTO, 2011), to the International Health Regulations (affecting the way that epidemics of climate-sensitive infectious diseases such as cholera are managed across borders; WHO, 2007), to the codes of practice of international humanitarian organizations (such as the Code of Conduct for the International Red Cross and Red Crescent Movement and NGOs in Disaster Relief; ICRC, 1995).

While approaches such as poverty reduction strategies are important in development planning at the national level, arguably the central framework for defining global development objectives is the Millennium Declaration and the associated MDGs. These have been agreed by all members of the United Nations as well as 23 international organizations, with a target date of 2015 (UN, 2011). These are also supported by international aid agreements, such as the Multilateral Debt Relief Initiative to cancel US$ 40 to 55 million dollars' worth of debt (IMF, 2011), and the commitment of economically advanced countries to commit 0.7% of gross national income to overseas development aid (UN ,1970). The eight MDGs break down into 21 quantifiable targets that are measured by 60 indicators (UN, 2011).

Neither DRM nor CCA are explicitly covered in the MDGs. However, they are strongly linked in practice. First, if disasters occur they can set back progress across many of the goals. Second, progress toward the MDGs can help to increase resilience to extreme weather events, and to climate change (Schipper and Pelling, 2006). Linking CCA and DRM with the MDGs is therefore important for the coherence of international development, and the target date of the Hyogo Framework for Action coincides with the intended completion of the MDGs (UNISDR, 2005b).

While there are exceptions, the majority of the LDCs, particularly in sub-Saharan Africa, are currently off track to reach most of the MDGs (UN, 2011). This has been attributed in part to financial, structural, and institutional weaknesses in the affected countries, and also by failure of most developed countries to reach the 0.7% aid target. Failure or delays in reaching the MDGs are therefore likely to be both a cause and a consequence of vulnerability to extreme weather and climate change (UNISDR, 2005b).

has three objectives of (1) influencing DRR public policy formulation (development); (2) increasing public accountability for effective policy administration (implementation); and (3) raising resources and political will for community-based DRR (mobilization). One of the five core strategies of the GNDR is to develop synergies between DRR and climate change to address underlying risk factors (sustainable development), including adapting local-level DRR monitoring infrastructure for climate adaptation, and input to the UNFCCC COP negotiations. Given the recent launch of the initiative there is no evaluation of effectiveness so far.

7.3.3.3. International Finance Institutions and Donors

7.3.3.3.1. Global Environment Facility

The GEF is an independent financial organization established in 1991 that provides grants to developing countries and countries with economies in transition for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. It has become the largest funder of projects to address global environmental challenges and it serves as the financial mechanism for the following conventions:

- Convention on Biological Diversity (CBD)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Stockholm Convention on Persistent Organic Pollutants (POPs)
- UN Convention to Combat Desertification (UNCCD).

The GEF administers the main international funds that have been made available under the UNFCCC for adaptation: the SCCF, which supports adaptation alongside development, technology transfer, capacity building, and sectoral approaches, and the LDCF, which particularly focuses on the development and implementation of NAPAs in the least-developed countries (LDCs). Ten international agencies [UNDP, the United Nations Environment Programme, the World Bank, the Food and

Agriculture Organization (FAO), the Inter-American Development Bank (IADB), the United Nations Industrial Development Organization, the International Fund for Agricultural Development, the European Bank for Reconstruction and Development (EBRD), and the African and Asian Development Banks] implement GEF projects, usually in partnership with national or other international agencies. Following a review of the implementation of the LDCF Fund by the UNFCCC's Subsidiary Body for Implementation, parties to the UNFCCC have requested the GEF, *inter alia*, to speed up the implementation process, update NAPAs, and work with its implementing agencies to improve communication with LDCs (UNFCCC, 2011). The GEF also provides interim secretariat services to the Adaptation Fund, established under the Kyoto Protocol of the UNFCCC, funded mainly through a percentage of the proceeds of the Certified Emission Reductions under the Clean Development Mechanism (Adaptation Fund, 2011a). The Fund finances climate change adaptation projects, including DRR projects, in developing countries (Adaptation Fund, 2011b).

7.3.3.3.2. The World Bank and Regional Development Banks

The major development banks (the African Development Bank, Asian Development Bank, EBRD, IADB, and World Bank Group) manage much of the funding for both climate change and disaster reduction. This includes, for example, the Pilot Program for Climate Resilience, covering a wide remit, including integration of climate risk and resilience into development planning (World Bank, 2009; Climate Funds Update, 2011).

Perhaps the clearest example of the strengths and challenges of international financing for DRM and CCA is provided by the Global Facility for Disaster Reduction and Recovery (GFDRR), managed by the World Bank. This is a partnership of the UNISDR system to support the implementation of the HFA. The GFDRR's mission is to mainstream disaster reduction and climate change adaptation into national policies, plans, and strategies to promote development and achieve the MDGs. The World Bank provides operational services to the GFDRR, on behalf of donors and other partnering stakeholders. The GFDRR supports international collaboration, and provides technical and financial assistance to low- and middle-income countries that are considered to be at high risk from disasters (GFDRR, 2010).

Two independent evaluations of the GFDRR have been conducted (Universalia Management Group, 2010; DFID, 2011). The facility has mobilized significant funds (over US$ 240 million in contributions and pledges from 2006 to 2009). The fund is considered relevant and responsive to stakeholders, and to play a unique role in helping to bridge knowledge, policy, and practice in DRR services, with good coverage of climate change adaptation (Universalia Management Group, 2010). It is also considered to be cost-effective in program implementation (DFID, 2011). However, the resources that have been mobilized through the fund remain much lower than those required, and partnerships, policy integration, and monitoring of results are considered uneven across countries. Despite these challenges, the facility is considered to have achieved important progress, and to be implementing the necessary steps to improve function and to scale up implementation (Universalia Management Group, 2010; DFID, 2011).

7.4. Options, Constraints, and Opportunities for Disaster Risk Management and Climate Change Adaptation at the International Level

7.4.1. International Law

As demonstrated in Section 7.2.5, existing tools and instruments of international law can assist with disaster risk reduction and management and in driving adaptation to climate change, recognizing at the same time that international law is limited in scope and enforceability when applied to addressing these challenges.

7.4.1.1. Limits and Constraints of International Law

Structurally, international law is both facilitated and constrained by the need for explicit or implicit acceptance by nation states, which create and comprise the system. It follows that the relevance of negotiated treaties depends on state consent, while customary law only exists if there is state practice and *opinio juris*. For instance, in the case of the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations noted in Section 7.2.5, only four of the 25 most disaster-prone states have signed up, limiting its relevance to many of the states that would most benefit from its provisions (Fisher, 2007). The International Bill of Rights, which at face value is highly relevant to disaster risk response and in supporting an obligation to assist with adapting to climate change, does not enjoy universal acceptance. Furthermore, because international law is made by and applicable to states, the many non-state actors relevant to disaster risk reduction and climate change adaptation are not subject to obligations – though as citizens they may benefit from the duty of states.

Some fields of international law provide tools that seem applicable to disaster risk management and/or adaptation to climate change, yet are constrained through inherent limited applicability. International humanitarian law (IHL) enshrined in the 1949 Geneva Conventions enjoys wide applicability due to universal adherence (Lavoyer, 2006; Fisher, 2007), but is limited to situations of armed conflict. In contrast, 'International Disaster Response Law' (IDRL) (see Fisher, 2007), sometimes proposed as a peacetime counterpart to IHL, not only lacks the central regime and universal adhesion of the Geneva Conventions, but further experiences challenges in coordination and monitoring (Fisher, 2007). As a second example, international law has on the one hand been described as "not yet equipped to respond adequately to the diverse causes of climate-induced migration" (Von Doussa et al., 2007; generally Biermann and Boas, 2010), while on the other hand the literature is in disagreement as to *whether* refugee law should provide the instruments to deal with the challenge of migration related to climate change. The application of international refugee law, as codified in the 1951 Convention relating to the Status of Refugees, to those who cross international borders due to climate-induced migration is indeed complex and limited (UNHCR, 2009). Reopening the Convention to expand the term 'refugee,' it is argued, would risk a renegotiation of the Convention and thus potentially result in lower levels of protection for the displaced (Kolmannskog and Myrstad, 2009).

7.4.1.2. Opportunities for the Application of International Law

The potential expansion of the concepts, definitions, and procedures known to international law can also be seen as future opportunity for international law to address the challenges of disaster risk reduction and adaptation to climate change.

Beyond the current international law obligations to mitigate the effects of climate change, facilitate disaster response, and mandate international facilitation of adaptation efforts (see Section 7.2.5), the fact that international law is shaped by nation states and evolves with state practice means that international law may also adapt to future realities. Expanding the interpretation and application of existing international law, and the introduction of new law for disaster response and climate change adaptation, are both plausible in the future.

A controversial candidate field for expanded interpretation is international refugee law. The extant definition of 'refugee' per the Refugee Convention and Protocol is any person who is outside their country of nationality and who, "owing to a well-founded fear of being persecuted" is unable or unwilling to return to their country. Some literature proposes the expansion of 'persecuted' to encompass being subject to environmental disaster or degradation (Warnock, 2007; Kolmannskog and Myrstad, 2009). Comparably, Article 7 of the International Covenant on Civil and Political Rights prohibits torture and "cruel, inhuman, or degrading punishment." Some literature notes the potential expansion of the meaning 'inhuman treatment' to include being left without basic levels of subsistence due to climate change impacts. A step further proposes a new international agreement to share the "emerging burden of climate-induced migration flows" and which "upholds the human rights of the individuals affected" (Von Doussa et al., 2007). The expansion of the definition of refugee remains highly controversial, with many states opposing the use of refugee law to address climate-related, transboundary movement of people.

The emerging legal doctrine of 'responsibility to protect' has also been proposed in application to natural disasters. The emergence of state practice in observing certain responsibilities "before, during, and after natural disasters occur" in the absence of obligations to do so supports an emerging responsibility to protect in the context of natural disaster, and sources of human rights law are to be used in promoting this doctrine (Saechao, 2007).

7.4.2. International Finance

The UNFCCC recognizes that in addition to the need to mitigate emissions of greenhouse gases and adapt to climate change, there is a responsibility on developed countries to support developing countries in this process (see Article 4.4 in Box 7-1). A starting point for the delivery of adaptation finance is the assessment of adaptation finance needs, which have also been interpreted as a proxy for adaptation costs (see Section 4.5). The UNFCCC (2007b) estimated the additional investment and financial flows needed worldwide to be US$ 48 to 171 billion in 2030 (or US$ 60 to 193 billion when also considering current investment needs for ecosystem adaptation). Some US$ 28 to 67 billion of this amount would be needed in developing countries (UNFCCC, 2007b). The largest uncertainty in these estimates is in the cost of adapting infrastructure, which may require anything between US$ 8 and 130 billion in 2030, one-third of which would be for developing countries. The UNFCCC (2007b) also estimated that an additional amount of about US$ 41 billion would be needed for agriculture, water, health, and coastal zone protection, most of which would be used in developing countries. Other studies providing estimates of the annual incremental costs of adaptation in developing countries include those by the World Bank (2006), Stern (2007), Oxfam International (2007), Watkins (2007), and the World Bank (2010b). These estimates are shown in Table 7-1, and discussed in more detail in Parry et al. (2009) and Fankhauser (2010).

While these different estimates highlight the high level of uncertainty, there appears to be consensus that global adaptation costs will total tens of billions of US dollars per year in developing countries. A review by the Organisation for Economic Co-operation and Development (OECD) of the estimates mentioned above found that there is very little quantified information on the costs of adaptation in developing countries, and most studies are constrained to a few sectors within countries (mostly coastal zones and, to a lesser extent, water, agriculture, and health) (Agrawala and Fankhauser, 2008). In addition, these studies assume relatively crude relationships and make strong assumptions, such as perfect foresight and high levels of autonomous adaptation. Almost no cross-sector studies have examined cumulative effects within countries, and only a handful of studies have investigated the wider macroeconomic consequences of impacts or adaptation. Moreover, most of the literature only considers adaptation to average changes in temperature or sea level rise. Little attention has been paid to more

Table 7-1 | Estimated annual adaptation costs and finance needs in developing countries.

	Assessment Year	US$ (Billion)	Time Frame
World Bank	2006	9 - 41	Present
Stern	2006	4 - 37	Present
Oxfam	2007	> 50	Present
UNDP	2007	86 - 109	2015
UNFCCC	2007	28 - 67	2030
World Bank	2010	70 - 100	2010 - 2050

Sources: World Bank, 2006, 2010b; Stern, 2007; Oxfam International, 2007; UNFCCC, 2007b; Watkins, 2007.

abrupt changes in mean conditions or to changes in the frequency and magnitude of extreme events (Agrawala and Fankhauser, 2008).

According to Agrawala and Fankhauser (2008), the consensus on global adaptation costs, even in order of magnitude terms, may therefore be premature. In addition, in most cases the estimates are neither attributed to specific adaptation activities, nor do they articulate the benefits of adaptation investment. Double counting between sectors and scaling up to global levels from very limited (and often local) source material limit utility. At the same time, a point also noted by Parry et al. (2009), many sectors and adaptations have not been included in the estimates.

In addition to these global estimates, total adaptation finance needs can also be assessed by aggregating national estimates, although this is hampered by the absence of a common method to make such estimates, and the fact that they are not available for all countries. The NAPAs (see Section 7.3.2 and Chapter 6), which have now been completed by most LDCs, are the most extensive effort to date to assess adaptation priorities and finance needs in developing countries. The cumulative cost of projects prioritized to respond to urgent and immediate adaptation needs is approximately US$ 1,660 million for the 43 countries that had completed their NAPAs by September 2009 (UNFCCC, 2010b). The divergence from the global estimates mentioned above can be explained by several factors: they cover only 43 LDCs, they include only prioritized projects, and they consider only urgent and immediate adaptation needs, not medium- to long-term needs (Persson et al., 2009).

A challenge for the international community is how to meet the adaptation finance needs that have been identified. The GEF operates the LDCF and SCCF, to provide funding to eligible developing countries to meet the 'additional' or 'incremental' costs of adaptation; the baseline costs of a project or program are borne by the recipient country, by other bilateral or multilateral donors, or both. The LDCF and SCCF rely on voluntary contributions from developed countries. As of May 2010, US$ 315 million had been pledged for adaptation under these two funds (US$ 221 million to the LDCF and US$ 94 million to the SCCF); of this amount, US$ 220 million has been allocated (US$ 135 million from the LDCF and US$ 85 million from the SCCF) (GEF, 2010a). In addition, the GEF has allocated all US$ 50 million it had made available to the SPA (GEF, 2008; see also Klein and Möhner, 2009).

The Adaptation Fund, which became operational in 2009, is operated by a special Adaptation Fund Board. It is the first financial instrument under the UNFCCC and its Kyoto Protocol that is not based solely on voluntary contributions from developed countries. It receives a 2% share of proceeds from project activities under the Clean Development Mechanism (CDM), but can also receive funds from other sources to fund concrete adaptation projects and programs (Persson et al., 2009). The actual amount of money that will be available from the Adaptation Fund depends on the extent to which the CDM is used and on the price of carbon. As of October 2010, the Adaptation Fund had received US$ 202.09 million, of which US$ 130.55 million was generated through CDM activities. Estimates of potential resources available for the Adaptation Fund from 31 October 2010 to 31 December 2012 range from US$ 288.4 million to US$ 401.5 million (Adaptation Fund, 2010).

While the GEF-managed funds have supported adaptation activities in some 80 countries (Persson et al., 2009), there has been criticism, particularly from developing countries, on how the funds are being managed (e.g., Mitchell et al., 2008; Klein and Möhner, 2009; Ministry of Foreign Affairs of Denmark and GEF Evaluation Office, 2009). In addition, concern has been voiced about the predictability and adequacy of funds, and the perceived equity and fairness of decisionmaking (Mace, 2005; Paavola and Adger, 2006; Müller, 2007; Persson et al., 2009). The GEF has acknowledged the criticism and indicated in reports to the COP how it is responding to it (GEF, 2009, 2010b). At the same time, developed countries have raised concern about fiduciary risks in some developing countries, which would need to be addressed through improved accountability and transparency before program-based adaptation can be supported by international finance (Mitchell et al., 2008; GEF, 2010b). The Adaptation Fund has not been operational long enough to allow for such an assessment but the first signals are positive, particularly regarding its governance structure and the option of direct access (Czarnecki and Guilanpour, 2009; Brown et al., 2010; Grasso, 2010).

In addition to the funds operating within the context of the UNFCCC, money for adaptation is provided through several other channels, including developing countries' domestic national, sectoral, and local budgets; bilateral and multilateral development assistance; and private-sector investments. This makes for an adaptation financing landscape that is highly fragmented, resulting in a proliferation not only of funds but also of policies, rules, and procedures (Persson et al., 2009). But despite the proliferation of funds, the amount of money currently available falls substantially short of the adaptation finance needs presented above.

In light of this shortfall, the 2009 Copenhagen Accord was a milestone in international climate finance. It refers to a collective commitment for developed countries to provide "new and additional resources … approaching USD 30 billion" in 'fast start' money for the 2010-2012 period, balanced between adaptation and mitigation, and sets a longer-term collective goal of mobilizing US$ 100 billion per year by 2020 from all sources (public and private, bilateral and multilateral) (Bodansky, 2010). Although the Copenhagen Accord was not adopted by the COP, the collective commitment and longer-term goal are also part of the Cancun Agreements, which the COP adopted a year later. Parties agreed that "scaled-up, new and additional, predictable and adequate funding shall be provided to developing country Parties, taking into account the urgent and immediate needs of developing countries that are particularly vulnerable to the adverse effects of climate change." In the meantime, the High-level Advisory Group on Climate Change Financing, established by the UN Secretary-General, had analyzed the feasibility of mobilizing US$ 100 billion per year by 2020. It concluded that "it is challenging but feasible to meet that goal. Funding will need to come from a wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance, the scaling up of existing sources, and increased private flows. Grants and highly concessional loans are crucial for adaptation in the most vulnerable developing countries, such as the least developed countries, small island developing States and Africa" (AGF, 2010).

An open question is how climate finance might be linked with other international finance flows. The Bali Action Plan referred to "means to incentivize the implementation of adaptation actions on the basis of sustainable development policies" in its section on the provision of financial resources. The Copenhagen Accord did not discuss the link between adaptation and development, even though the issue of 'mainstreaming' – integrating adaptation to climate change into mainstream development planning and decisionmaking – was much debated in the pre-Copenhagen negotiations on adaptation finance (Persson et al., 2009; Klein, 2010). From an operational perspective, mainstreaming adaptation into development makes common sense: both contribute to enhancing human security, and opportunities to create synergies between the two are increasingly recognized and pursued (Gigli and Agrawala, 2007; Klein et al., 2007; Kok et al., 2008; Gupta and Van de Grijp, 2010). Besides, there is a range of activities that can be seen as contributing to both adaptation and development objectives (McGray et al., 2007).

But from a climate policy perspective, mainstreaming creates a dilemma (Persson and Klein, 2009; Klein, 2010). Financial flows for adaptation and those for development – for example, official development assistance (ODA) – are managed separately. One of the arguments in favor of mainstreamed adaptation is that it makes more efficient use of financial and human resources than adaptation that is designed, implemented, and managed as stand-alone activities (i.e., separately from ongoing development planning and decisionmaking). However, developing countries have expressed the concern that, as a result of donors seeking to create synergies between adaptation and development, finance for adaptation will not be new and additional but in effect will be absorbed into ODA budgets of a fixed size (Michaelowa and Michaelowa, 2007). The concern is fueled by the fact that the amount of money currently available for adaptation falls short of the estimated adaptation finance needs in developing countries. A second, related concern is that mainstreaming could divert any new and additional funds for adaptation into more general development activities, thus limiting the opportunity to evaluate, at least quantitatively, their benefits with respect to climate change specifically (Yamin, 2005). Third, there is concern that donors' use of ODA to pursue mainstreamed adaptation could impose conditionalities on what should be a country-driven process (Gupta et al., 2010).

As mentioned in Section 7.3.2, the Cancun Agreements established the Green Climate Fund as a new entity operating the financial mechanism under Article 11. The Green Climate Fund is not yet operational and it is too early to say how it might address the mainstreaming dilemma, or even how important it will be for climate adaptation in developing countries. All that can be said at this moment is that in the Cancun Agreements, Parties decided that "a significant share of new multilateral funding for adaptation should flow through the Green Climate Fund."

7.4.3. Technology Transfer and Cooperation

7.4.3.1. Technology and Climate Change Adaptation

Technologies receive prominent attention both in adaptation to emerging and future impacts of climate change as well as in mitigating current disasters. The sustainability, operation, and maintenance of technologies can be challenging in many developing countries due to lack of resources, human capacity, and cultural differences. Moreover, technology transfer is complex and requires capacity building as well as a client (technology user) focus as opposed to a developer (technology designer) focus (O'Brien et al., 2007). Intellectual property rights are rarely an issue in the availability and use of technologies for adaptation (Murphy, 2011) but when they are, adequate methods are needed that foster affordable deployment of new technologies but preserve the incentives for technology developers (Doig, 2008). While the importance of transferring technologies from developers/owners to would-be users is widely recognized, the bulk of the literature seems to address the issues at a rather generic level, without going into the details of what technologies for adaptation would need to be transferred in different impact sectors from where to where and via what mechanisms. Institutional, political, technological, economic, information, financial, cultural, legal, and participation and consultation obstacles can hinder the transfer of mitigation and adaptation technologies and concerted efforts are required to overcome those impediments (IEA, 2001). Private-public partnership as a policy instrument could well be a mechanism for transferring the required technologies for adaptation projects (Agrawala and Fankhauser, 2008). In the adaptation literature, publications addressing the transfer of technologies important for reducing vulnerability and increasing the ability to cope with weather-related disasters are even scarcer. This section reviews literature on technologies for adaptation and the issues involved in international technology transfer of such technologies.

The Special Report on *Methodological and Technological Issues in Technology Transfer* by the IPCC defines the term 'technology transfer' as a "broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions" (IPCC, 2000, p. 3). The report uses a broad and inclusive term 'transfer' encompassing diffusion of technologies and technology cooperation across and within countries. It evaluates international as well as domestic technology transfer processes, barriers, and policies. This section focuses on the international aspects.

Adaptation to climate change involves more than merely the application of a particular technology (Klein et al., 2005). Adaptation measures include increasing robustness of infrastructural designs and long-term investments, increasing flexibility of vulnerable managed systems, enhancing adaptability of natural systems, reversing trends that increase vulnerability, and improving societal risk awareness and preparedness. In the case of disasters related to extreme weather events, anticipatory

Box 7-3 | Examples of Technologies for Adaptation in Asia

In Asia, adaptation to climate change, variability, and extreme events at the community level are small scale and concentrate mainly on agriculture, water, and disaster amelioration (Alam et al., 2007). They focus on the livelihood of affected communities, raise awareness to change practices, diversify agriculture, and promote water conservation. For example, Saudi Arabia has already built 215 dams for water storage and 30 desalination plants, passed water protection and conservation laws, and initiated leakage detection and control schemes as well as advanced irrigation water conservation schemes and a system for modified water pumping as part of its climate change adaptation program (Alam et al., 2007). In India, a combination of traditional and innovative technological approaches is used to manage drought risk. Technological management of drought (e.g., development and use of drought tolerant cultivars, shifting cropping seasons in agriculture, flood and drought control techniques in water management) is combined with model-based seasonal and annual to decadal forecasts. Model results are translated into early warning in order to take appropriate drought protection measures (Alam et al., 2007). In China, adaptation technologies have been widely used for flood disaster mitigation (Alam et al., 2007). Another example is related to the Philippines where a typhoon in 1987 completely destroyed over 200,000 homes. The Department of Social Welfare and Development initiated a program of providing typhoon-resistant housing for the population in the most typhoon-prone areas (Diacon, 1992). The so-called Core Shelter houses have typhoon resistant features and can endure wind speeds up to 180 km hr^{-1}. The technology was proved to be successful by providing the required protection and was adopted recently in regions stricken by a landslide (Government of the Philippines, 2008) and typhoons (Government of the Philippines, 2010), partly financed by UNDP.

adaptation is more effective and less costly than emergency measures and retrofitting, and immediate benefits can be gained from better adaptation to climate variability and extreme events. Some factors that determine adaptive capacity of human systems are the level of economic wealth, access to technology, information, knowledge and skills, and existence of institutions, infrastructure, and social capital (Smit et al., 2001; Christoplos et al., 2009).

An extensive list of 'soft' options that are vital to building capacity to cope with climatic hazards with references to publications that either describe the technology in detail or provide examples of its application is available (Klein et al., 2000, 2005). For example, the applications in coastal system adaptation include various types of geospatial information technologies such as mapping and surveying, videography, airborne laser scanning (lidar), satellite and airborne remote sensing, global positioning systems in addition to tide gauges and historical and geological methods. These technologies help formulate adaptation strategies (protection versus retreat), implement the selected strategy (design, construction, and operation), and provide early warning (UNFCCC, 2006a). Another set of examples includes technologies to protect against sea level rise: dikes, levees, floodwalls, seawalls, revetments, bulkheads, groynes, detached breakwaters, floodgates, tidal barriers, and saltwater intrusion barriers among the hard structural options, and periodic beach nourishment, dune restoration and creation, and wetland restoration and creation as examples of soft structural options (Klein et al., 2000, 2005). A combination of these technologies selected on the basis of local conditions constitutes the protection against extreme events in coastal regions. Structural measures are localized solutions and there is a need for localized information such as their environmental and hydrologic impacts. In addition, there are a series of indigenous options (flood and drought management) that might be valuable in regions to be affected by similar events (Klein et al., 2005, p. 19). It is also important to integrate technology transfer efforts for CCA and DRR needs with sustainable development efforts to avoid conflicts and foster synergies between them (Hope Sr., 1996; Sanusi, 2005). Adaptation is normally assumed to be benign for development but Eriksen and Brown (2011) challenge this assumption, arguing that there is emerging evidence that adaptation measures run counter to principles of sustainable development, as both social equality and environmental integrity can be threatened. Placing responses to extreme events into the larger context of other societal and environmental changes will be vital for sustainable development (Yohe et al., 2007; Eriksen et al., 2011).

A report by the UNFCCC (2006a) summarizes the technology needs identified by Parties not included in Annex I to the Convention. Curiously, only one country mentioned 'potential for adaptation' among the commonly used criteria for prioritizing technology needs. Among 30 technologies listed in the report, the technology needs relevant for coping and adapting to weather extremes include, for example, improved drainage, emergency planning, raising buildings and land, and protecting against sea level rise. Many of these are good examples of measures that link DRR and CCA objectives, namely to reduce overall ecological and social vulnerability. Another UNFCCC report (2006b) observes that, unlike those for mitigation, the forms of technology for adaptation are often rather familiar. Many have been used over generations in coping with floods, for example, by building houses on stilts or by cultivating floating vegetable plots. Some other types of technologies draw on new developments in, for example, advanced materials science and satellite remote sensing (see Box 7-3). The UNFCCC report (2006b) provides an overview of the old and new technologies available in adapting to changing environments, including climate change. The Disaster Reduction Hyperbase in Asia is a web-based collection of new and traditional indigenous technologies relevant to DRM that also promotes communication among developing and industrial countries (Kameda, 2007).

7.4.3.2. Technologies for Extreme Events

Approaching the issues of technologies to foster adaptation to extreme weather events and their impacts from the direction of disaster mitigation, Sahu (2009) presents an overview of diverse technologies that might be applied in various stages of disaster management. The list of technologies for adaptation to weather-related extreme events includes early warning and disaster preparedness; search and rescue for disaster survivors; water supply, purification, and treatment; food supply, storage, and safety; energy and electricity supply; medicine and healthcare for disaster victims; disease surveillance; sanitation and waste management; and disaster-resistant housing and construction (Sahu, 2009).

Developing wind-resistant building technologies is crucial for reducing vulnerability to high-wind conditions like storms, hurricanes, and tornadoes. A report by the International Hurricane Research Centre presents hurricane loss reduction devices and techniques (IHRC, 2006). The Wall of Wind testing apparatus (multi-fan systems that generate up to 209 km hr^{-1} winds and include water-injection and debris-propulsion systems with sufficient wind field sizes to test the construction of small single-story buildings) will improve the understanding of the failure mode of buildings and hence lead to technologies and products to mitigate hurricane impacts (Fugate and Crist, 2008).

An absolutely crucial aspect of managing weather extremes both under the present and future climate regime is the ability to forecast and provide early warning. Downscaling projections from global climate models could provide useful information about the changing risks. It is important to note that really useful early warning systems would provide multi-hazard warning and warnings on vulnerability development to the extent it is possible. Satellite and aerial monitoring, meteorological models, and computer tools including geographic information systems (GIS) as well as local and regional communication systems are the most essential technical components. (The focus on technology here does not negate the importance of social and communication aspects of early warning.) The use of GIS in the support of emergency operations in the case of both weather and non-weather disasters is becoming increasingly important in the United States. The benefits of using GIS technologies include informing the public, enabling officials to make smarter decisions, and facilitating first-responder efforts to effectively locate and rescue storm victims (NASCIO, 2006). Lack of locally useable climate change information about projected changes in extreme weather events remains an important constraint in managing weather-related disasters, especially in developing countries. Therefore there is a need to develop regional mechanisms to support in developing and delivering downscaling techniques and tools (see Section 3.2.3 for details on downscaling regional climate models) and transferring them to developing countries.

Space technologies (such as Earth observation, satellite imagery, real-time application of space sensors, mapping) are important in the reduction of disasters, including extreme weather and climate events such as drought, flood, and storms (Rukieh and Koudmani, 2006). These technologies can be particularly helpful in the risk assessment, mitigation, and preparedness phases of disaster management by identifying risk-prone areas, establishing zoning restrictions and escape routes, etc. Space technologies are important for early warning and in managing the effects of disasters. For incorporating the routine use of space technology-based solutions in developing countries, there is a need to increase awareness, build national capacity, and also develop solutions that are customized and appropriate to their needs (Rukieh and Koudmani, 2006). A good example of the application of space technology at international scales and for early warning is the joint initiative of WMO, the National Oceanic and Atmospheric Administration, the US Agency for International Development, and the Hydrologic Research Center on global flash flood guidance. The system uses global data produced by a global center and downscales the global information to regional products that are sent to national entities for further downscaling at the national level and then disseminated to users and communities (WMO, 2007, 2010). It is also important to note that there are existing capabilities within some particularly exposed developing countries (such as India, Bangladesh, China, Philippines) with well-developed remote-sensing capabilities of their own, or existing arrangements with other space agency suppliers.

Support for risk reduction and relief agencies and governments depends, among other factors, on timely availability of information about the scale and nature of these disasters (Holdaway, 2001). Currently, ground-based sources provide most of such information. This could be improved by using input from space-based sensor systems, both for disaster warning and disaster monitoring where the scale of devastation cannot adequately be monitored from ground-based information sources alone. A global space-based monitoring and information system, with the associated ability to provide advanced warning of many types of hazards, can be combined with the latest developments in sensor technology (optical, infrared, radar) including a UK initiative on high-resolution imaging from a microsatellite (Holdaway, 2001). The literature suggests that transferring these technologies and the related know-how will be important for building capacities in CCA and DRR in countries where they are still missing (*medium certainty, limited evidence*).

Microsatellites (low weights and small sizes, just under or well below 500 kg) are seen as an important technology for the detection of and preparation for weather-related hazards in other countries as well. Shimizu (2008) emphasizes the importance of international cooperation in this area. He observes that only a few countries are able to develop large rockets and satellites and launch them from their own territories. Several Asian countries have been cooperating with OECD countries to develop small Earth observation satellites, like DAICHI (Advanced Land Observing Satellite) and WINDS (Wideband Internetworking engineering test and demonstration satellite) that include both optical and microwave sensors. DAICHI operated between 2006 and 2011 based on cooperation of Asian countries with the United States and the European Union and made an important contribution to emergency observations of regions hit by major disasters in this period (JAXA, 2011).

Mitigation of adverse cyclone impacts involves reliable tropical cyclone forecasting and warnings, and efficient ways to convey the information to stakeholders, users, and the general public (Lee et al., 2006). It is important that NMHSs take advantage of the advances in communication technology such as wireless broadband access, Global Positioning System (GPS), and GIS to enhance the relevance and effectiveness of warnings, options, and backup capabilities to disseminate warnings through multiple and diverse channels (Lee et al., 2006). Natural hazards management has advanced to address a major challenge: turning real-time data provided by new technologies (e.g., satellite- and ground-based sensors and instruments) into information products to help people make better decisions about their own safety and prosperity (Groat, 2004).

The literature about technology transfer to foster adaptation to changes in extreme events induced by climate change is very limited. It was necessary to broaden the scope of the literature review and embrace climate change adaptation in general in order to gain lessons about the processes, channels, stakeholders, and barriers of technology transfer. In addition, useful insights were inferred from the literature on technology transfer to support climate change mitigation, disaster risk reduction (prevention, mitigation, and preparedness), and other related areas. The DRR literature on technology development and transfer documents the expanding international cooperation in forecasting and monitoring extreme weather events by collecting and disseminating satellite-based information and the international transfer of know-how to interpret it. There is increasing emphasis on the importance of establishing close linkages across all EWS components ranging from collection of hydro-meteorological data, forecasting how nature will respond (e.g., weather or flood forecasting), to communicating information (or warnings) to decisionmakers (sectoral users or communities) (*medium agreement, limited evidence*).

7.4.3.3. Financing Technology Transfer

Climate change mitigation has been the primary focus of the financing mechanisms and innovative financing in recent years. In contrast, the transfer of technologies for adaptation is hampered by insufficient incentive regimes, increased risks, and high transaction costs (Klein et al., 2005). Yet the lessons from the transfer of mitigation technologies are relevant for adaptation: results of the penetration of energy and industrial technologies in the developing countries depend on many factors ranging from labor skills, market conditions, achieved level of technological development, the reliability of basic services (electricity and water), availability of spare parts, etc. A combination of interrelated socioeconomic, institutional, and governance issues would often determine the success or failure of technology transfer, rather than the technologies themselves (Klein et al., 2005, p. 23). These factors are also important in transferring technologies for adaptation because they determine the feasibility and efficiency of adopting the transferred technologies (e.g., regulations to build and install them, skilled labor, water and electricity to operate them).

UNFCCC (2005) addresses the transfer of environmentally sound technologies for adaptation to climate change: the needs for and the identification and evaluation of technologies for adaptation to climate change, and financing their transfer. Cost is one of the main barriers in technology transfer; therefore innovative financing for the development and transfer of technologies is needed. Potential sources of funding for technology transfer include bilateral activities of Parties, multilateral activities such as the GEF, the World Bank, or regional banks, the SCCF, the LDCF, financial flows generated by Joint Implementation and CDM projects, and the private sector (see also Section 7.3.3.3). The GEF funds for adaptation activities include the SPA trust fund, the LDCF, and the SCCF. In addition, the GEF is providing secretariat services to the Adaptation Fund Board under the Kyoto Protocol (see also Section 7.4.2).

Climate variability is already a major impediment to development and 2% of World Bank funds are devoted to disaster reconstruction and recovery (World Bank, 2008). In order to use available funds efficiently, the World Bank (2009) developed the screening tool ADAPT (Assessment & Design for Adaptation to Climate Change: A Prototype Tool), a software-based tool for assessing development projects for potential sensitivities to climate change. The tool combines climate databases and expert assessments of the threats and opportunities arising from climate variability and change. As of 2011, the knowledge areas covered by the tool cover agriculture and irrigation in India and sub-Saharan Africa and, for all regions, various aspects of biodiversity and natural resources.

Both conventional and innovative options for financing the transfer of technologies for adaptation might be explored. As conventional options, the GEF funds (SPA, LDCF, and SCCF) provide opportunities for accessing financial resources that could be used for deployment, diffusion, and transfer of technologies for adaptation, including initiatives on capacity building, partnerships, and information sharing. Projects identified in technology needs assessments could also be implemented using these financial opportunities. Based on these experiences as well as on special needs of groups of countries such as small island developing states and LDCs, further guidance could be provided to the GEF on funding technologies for adaptation. In addition, there is an opportunity to explore innovative financing mechanisms that can promote, facilitate, and support increased investment in technologies for adaptation (UNFCCC, 2005).

Concerning financing of technological development and transfer, a report by the Expert Group on Technology Transfer (UNFCCC, 2009a) classifies technologies by stage of maturity, the source of financing (public or private sector), and whether they are under or outside the UNFCCC and estimates the financing resources currently available for technology research, development, deployment, diffusion, and transfer. The estimates for financing mitigation technologies are between US$ 70 and 165 billion per year. In the adaptation area, the report claims that research and development is focused on tailoring technologies to specific sites and applications and thus the related expenditures become part of the project costs. Current spending on adaptation projects in developing countries is about US$ 1 billion per year (UNFCCC, 2009a).

The literature clearly shows that the transfer of technologies for adaptation lags behind the transfer of mitigation technologies in terms of the scales of attention and funding. Funding transfer and funding mechanisms for technologies that help reduce vulnerability to climate variability, particularly to weather-related extreme events, appear to be as important for both CCA and DRR (*high confidence*).

7.4.4. Risk Sharing and Transfer

This section examines the current and potential role of the international community – international financial institutions, NGOs, development organizations, private market actors, and the emerging adaptation community – in enabling access to insurance and other financial instruments that share and transfer risks of extreme weather. The international transfer and sharing of risk is an opportunity for individuals and governments of all countries that cannot sufficiently diversify their portfolio of weather risk internally, and especially (as discussed in Section 6.3.3) for governments of vulnerable countries that do not wish to rely on ad hoc and often insufficient post-disaster assistance.

Experience shows that the international community can play a role in enabling individual, national, and international risk-sharing and transfer strategies (*high confidence*). The following discussion identifies successful practices, or value added, as well as constraints on this role.

7.4.4.1. International Risk Sharing and Transfer

Risk transfer (usually with payment) and risk sharing (usually informal with no payment) are recognized by the international community as an integral part of DRM and CCA (see Case Study 9.2.13 for definitions). The 2005 HFA calls on the disaster community "to promote the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters" (UNISDR, 2005a, p. 11). Similarly, the 2007 Bali Action Plan calls for consideration of risk-sharing and transfer mechanisms as a means for enhancing adaptation (UNFCCC, 2007a). The Plan builds on the mandate to consider insurance as set out by Article 4.8 of the UNFCCC and Article 3.14 of the Kyoto Protocol.

Often by necessity risk sharing and transfer are international. Local and national pooling arrangements (discussed in Sections 5.5.2 and 6.3.3) may not be viable for statistically dependent (co-variant) risks that cannot be sufficiently diversified. A single event can cause simultaneous losses to many insured assets, violating the underlying insurance principle of diversification. For this reason, primary insurers, individuals, and governments (particularly in small countries) rely on risk-sharing and transfer instruments that diversify their risks regionally and even globally. A few examples can serve to illustrate international arrangements:

- A government receives international emergency assistance and loans after a major disaster.
- A family locates a relative in a distant country who provides post-disaster relief through remittances.
- After a major disaster, a farm household takes out a loan from an internationally backed micro-lending institution.
- An insurer purchases reinsurance from a private reinsurance company, which spreads these risks to its international shareholders.
- A government issues a catastrophe bond, which transfers risks directly to the international capital markets.
- Many small countries form a catastrophe insurance pool, which diversifies risks and better enables them to purchase reinsurance.

Not only are these financial arrangements international in character, but many are supported by the international development and climate adaptation communities (see, especially, UNISDR, 2005b; UNFCCC, 2009b). At the outset it is important to point out that these instruments cannot stand alone but must be viewed as part of a risk management strategy, for which cost-effective risk reduction is a priority.

7.4.4.2. International Risk-Sharing and Transfer Mechanisms

This section reviews international mechanisms for sharing and transferring risk, including remittances, post-disaster credit, insurance and reinsurance, alternative insurance mechanisms, and regional pooling arrangements.

7.4.4.2.1. Remittances

Remittances – transfers of money from foreign workers or expatriate communities to their home countries – make up a large part of informal risk sharing and transfer, even exceeding official development aid flows. In 2010, the official worldwide flow of remittances was estimated at US$ 325 billion, and unrecorded flows may add another 50% or more. In some cases, remittances can be as large as one-third of the recipient country's gross domestic product (World Bank, 2011b).

A number of studies show that remittances increase substantially following disasters, often exceeding post-disaster donor assistance (Lucas and Stark, 1985; Miller and Paulson, 2007; Yang and Choi, 2007; Mohapatra et al., 2009). Payments can be sent through professional money transfer organizations, but often these channels break down and remittances are carried by hand (Savage and Harvey, 2007). While simple in concept, remittances can be complicated by associated transfer fees. A survey carried out in the United Kingdom found that for an average-sized transfer, the associated costs could vary between 2.5 and 40% (DFID, 2005). Information pertinent to the transfer is often obscure or in an unfamiliar language, and transfers across some borders have been complicated due to initiatives taken by developed nations to counter international money laundering and terrorism financing (Fagen and Bump, 2006). Finally, a major problem is difficulties in communicating with relatives abroad, as well as the high potential of losing necessary documents in a disaster.

The international community has been active in reducing the costs and barriers to post-disaster remittances. DFID, among other development organizations, supports financial inclusion policies including mobile banking and special savings accounts earmarked for disaster recovery that will greatly reduce transaction costs. High-tech proposals for assuring security have included biometric identification cards and retina scanners as forms of identification (DFID, 2005; Pickens et al., 2009).

7.4.4.2.2. Post-disaster credit

One of the most important post-disaster financing mechanisms, credit provides governments and individuals with resources after a disaster, yet with an obligation to repay at a later time. Governments and individuals of highly vulnerable countries, however, can have difficulties borrowing from commercial lenders in the post-disaster context. Since the early 1980s, the World Bank has thus initiated over 500 loans for recovery and reconstruction with a total disbursement of more than US$ 40 billion (World Bank, 2006), and the Asian Development Bank also reports large loans for this purpose (Arriens and Benson, 1999). With the growing importance of pre-disaster planning, a recent innovation on the part of international organizations is to make pre-disaster contingent loan arrangements – for example, the World Bank's catastrophe deferred drawdown option, which disburses quickly after the government declares an emergency (World Bank, 2008).

For micro-finance institutions (MFIs), post-disaster lending has associated risks given increased demand that tempts relaxed loan conditions or even debt pardoning. This risk is particularly acute in vulnerable regions. Recognizing the need for a risk transfer instrument to help MFIs remain solvent in the post-disaster period, the Swiss State Secretariat for Economic Affairs (SECO) and the IADB, as well as private investors, created the Emergency Liquidity Facility (ELF) (UNFCCC, 2008). Located in Costa Rica, ELF provides needed and immediate post-disaster liquidity at low rates to MFIs across the region.

7.4.4.2.3. Insurance and reinsurance

Insurance is an instrument for distributing disaster losses among a pool of at-risk households, farms, businesses, and/or governments, and is the most recognized form of international risk transfer. The insured share of property losses from extreme weather events has risen from a negligible level in the 1950s to approximately 20% of the total in 2007 (Mills, 2007).

Insurance and reinsurance markets attract capital from international investors, making insurance an instrument for transferring disaster risks over the globe. The market is highly international in character, yet uneven in its cover. In the period 2000 to 2005, for example, US insurers purchased reinsurance annually from more than 2,000 different non-US reinsurers (Cummins and Mahul, 2009, p. 115). From 1980 through 2003, insurance covered 4% of total losses from climate-related disasters (estimated at about US$ 1 trillion) in developing countries compared to 40% in high-income countries (Munich Re, 2003).

The international community is playing an active role in enabling insurance in developing countries, particularly by supporting micro- and sovereign (macro) insurance initiatives. The following four examples illustrate this role:

- The World Bank and World Food Programme provided essential technical assistance and support for establishing the Malawi pilot micro-insurance program (see discussion in Section 5.5.2), which provides index-based drought insurance to smallholder farmers (Hess and Syroka, 2005; Suarez et al., 2007).
- The Mongolian government and World Bank support the Mongolian Index-Based Livestock Insurance Program (see Section 5.5.2) by absorbing the losses from very infrequent extreme events (over 30% animal mortality) and providing a contingent debt arrangement to back this commitment, respectively (Skees and Enkh-Amgalan, 2002; Skees et al., 2008).
- The World Food Programme successfully obtained an insurance contract through a Paris-based reinsurer to provide insurance to the Ethiopian government, which assures capital for relief efforts in the case of extreme drought (Hess, 2007).
- The governments of Bermuda, Canada, France, and the United Kingdom, as well as the Caribbean Development Bank and the World Bank, have recently pledged substantial contributions to provide start-up capital for the Caribbean Catastrophe Risk Insurance Facility (discussed in Section 7.4.4.2.5) (Cummins and Mahul, 2009).

These early initiatives, especially micro-insurance schemes, are showing promise in reaching the most vulnerable, but also demonstrate significant challenges to scaling up current operations. Lack of data, regulation, trust, and knowledge about insurance, as well as high transaction costs, are some of the barriers (Hellmuth et al., 2009).

As discussed in Case Study 9.2.13, insurance and other risk transfer instruments can promote DRR and CCA in multiple ways by providing the means to finance recovery, thus reducing long-term losses; adding to knowledge about risks; creating incentives (and imperatives) for risk reduction; and providing the safety net necessary for farms and businesses to take on cost-effective, yet risky, investments that reduce their vulnerability to climate change (Linnerooth-Bayer et al., 2009; Warner et al., 2009b).

7.4.4.2.4. Alternative insurance instruments

Alternative insurance-like instruments, sometimes referred to as risk-linked securities, are financing devices that enable risk to be sold in international capital markets. Given the enormity of these markets, there is a large potential for alternative or non-traditional risk financing, including catastrophic risk (CAT) bonds (explained below, and in Section 6.3.3 and Case Study 9.2.13), industry loss warranties, sidecars (a company purchases a portion or all of an insurance policy to share in the profits and risks), and catastrophic equity puts, all of which are playing an increasingly important role in providing risk finance for large-loss events. A discussion of these instruments goes beyond the scope of this chapter, but it is worth drawing attention to the most prominent risk-linked security, the CAT bond, which is a fully collateralized instrument whereby the investor receives an above-market return when a specific natural hazard event does not occur (e.g., a Category 4 hurricane or greater), but shares the insurer's or government's losses by sacrificing interest or principal following the event if it does occur.

Over 90% of CAT bonds are issued by insurers and reinsurers in developed countries. Although it is still an experimental market, CAT bond placements more than doubled between 2005 and 2006, with a peak at US$ 4.7 billion in 2006 (Cummins and Mahul, 2009), but declining to US$ 3.4 billion in 2009 (Munich Re, 2010).

In 2006 and 2009, the first government-issued disaster relief CAT bond placements were executed by Swiss Re and Deutsche Bank Securities to provide funds to Mexico to insure its catastrophe fund FONDEN against earthquake and (in 2009) hurricane risk, and thus to defray costs of disaster recovery and relief (Cardenas et al., 2007). The World Bank provided technical assistance for these transactions. Although the transaction costs of the Mexican CAT bond were large, and basis risk (the risk that the bond trigger will not be highly correlated with losses) is a further impediment to their success, it is expected that this form of risk transfer will become increasingly attractive especially to highly exposed developing country governments (Lane, 2004). As discussed in Chapter 6, a large number of government treasuries are vulnerable to catastrophic risks, and post-disaster financing strategies generally have high opportunity costs for developing countries.

International and donor organizations have played an important role in another case of sovereign risk transfer (discussed in Section 9.2.13). In 2006, the World Food Programme purchased an index-based insurance instrument to support the Ethiopian government-sponsored Productive Safety Net Programme, which provides immediate cash payments in the case of food emergencies. While this transaction relied on traditional reinsurance instruments, there is current interest in issuing a CAT bond for this same purpose. Tomasini and Van Wassenhove (2009) note the important role that securitized instruments can play in providing backup for humanitarian aid when disasters strike.

7.4.4.2.5. Regional risk pools

Regional catastrophe insurance pools are a promising innovation that can enable highly vulnerable countries, and especially small states, to more affordably transfer their risks internationally. By amalgamating risks across individual countries or regions and accumulating reserves over time, catastrophe insurance pools generate diversification benefits that can eventually reduce insurance premiums. There is also growing empirical evidence that catastrophe insurance pools have been able to diversify intertemporally and thus dampen the volatility of the reinsurance pricing cycle and offer secure premiums to the insured governments (Cummins and Mahul, 2009).

As a recent example (discussed in Section 6.3.3 and Case Study 9.2.13), the Caribbean Catastrophe Risk Insurance Facility (CCRIF) was established in 2007 to provide Caribbean Community governments with an insurance instrument at a significantly lower cost (about 50% reduction) than if they were to purchase insurance separately in the financial markets. Governments of 16 island states contributed resources commensurate with their exposure to earthquakes and hurricanes, and claims will be paid depending on an index for hurricanes (wind speed) and earthquakes (ground shaking). Early cash payments received after an event will help to mitigate the typical post-disaster liquidity crunch (Ghesquiere et al., 2006; World Bank, 2007a,b).

7.4.4.3. Value Added by International Interventions

International financial institutions, donors, and other international actors have played a strongly catalytic role in the development of catastrophic risk-financing solutions in vulnerable countries, most notably by:

- *Exercising convening power*, for example, the World Bank coordinated the development of the CCRIF (Cummins and Mahul, 2009)
- *Supporting public goods* for development of risk market infrastructure, for example, donors might consider funding the weather stations necessary for index-based weather derivatives
- *Providing technical assistance*, for example, the World Food Programme carried out risk assessments and provided other assistance to support the Ethiopian sovereign risk transfer (Hess, 2007), and the World Bank provided technical assistance for the Mexican CAT bond (Cardenas et al., 2007)
- *Enabling markets*, for example, DFID is active in creating the legal and regulatory environment to facilitate access to banking services, which, in turn, greatly expedite remittances (DFID, 2005; Pickens et al., 2009)
- *Financing risk transfer*, as examples, the Bill Gates Foundation subsidizes micro-insurance in Ethiopia (Suarez and Linnerooth-Bayer, 2010); the World Bank provides low-cost capital backing for the Mongolian micro-insurance program (Skees et al., 2008); the Swiss SECO and the IADB provide low-interest credit to the ELF (UNFCCC, 2008); and many countries have contributed to the CCRIF reserve fund (Cummins and Mahul, 2009).

Though only a few of many examples of involvement by the international community in risk-sharing and transfer projects, they show that international financial institutions and development/donor organizations can assist and enable risk-sharing and transfer initiatives in diverse ways, which raises the question of their value added. Largely uncontested is the value of creating the institutional conditions necessary for community-based risk sharing and market-based risk transfer, yet, direct financing, especially of insurance, is controversial. Critics point to the 'economic efficiency principle' discussed in Section 7.2.2, and argue that public and international support, especially in the form of premium subsidies, can distort the price signal and weaken incentives for taking preventive measures, thus perpetuating vulnerability. Supporters point to the 'solidarity principle' discussed in Section 7.2.3 and the important role that solidarity has played in the social systems of the developed world (Linnerooth-Bayer and Mechler, 2008). Other types of assistance, like providing reinsurance to small insurers, can crowd out the (emerging) role of the private market. Finally, critics point out that it may be more efficient to provide the poor with cash grants than to subsidize insurance (Skees, 2001; Gurenko, 2004).

Recognizing these concerns, there may be important and valid reasons for interfering in catastrophe insurance and other risk-financing markets in specific contexts (see discussions by Cummins and Mahul, 2009; Linnerooth-Bayer et al., 2010), especially if:

- The private market is non-existent or embryonic, in which case enabling support (e.g., to improve governance, regulatory institutions, as well as knowledge creation) may be helpful.
- The private market does not function properly, in particular, if premiums greatly exceed the actuarially fair market price due, for example, to limitations on private capital and the uncertainty and ambiguity about the frequency and severity of future losses (Kunreuther and Michel-Kerjan, 2009). In this case economically justified premiums that are lower than those charged by the imperfect private market may be appropriate (Froot, 1999; Cutler and Zeckhauser, 2000).
- The target population cannot afford sufficient insurance coverage, in which case financial support that does not appreciably distort incentives may be called for. The designers of the Mongolian program, for example, argue that subsidizing the 'upper layer' is less price-distorting than subsidizing lower layers of risk because the market may fail to provide insurance for this layer (Skees et. al., 2008).
- The alternative is providing 'free' aid after the disaster happens.

7.4.5. Knowledge Acquisition, Management, and Dissemination

A close integration of DRR and CCA and their mainstreaming into sustainable development agendas for managing risks across scales calls for multiple ways of knowledge acquisition and development, management, sharing, and dissemination at all levels. Knowledge on the level of exposure to hazards and vulnerabilities across temporal and geographical scales (Louhisuo et al., 2007; Heltberg et al., 2008; Kaklauskas et al., 2009); the legal aspects of DRM and CCA; financing mechanisms at different scales; and information on access to appropriate technologies and risk-sharing and transfer mechanisms for disaster risk reduction (see Sections 7.4.1-7.4.4) are key to integrated risk management. Collaboration among scientists of different disciplines, practitioners, policymakers, and the public is pertinent in knowledge acquisition, management, and accessibility (Thomalla et al., 2006). The type, level of detail, and ways of generation and dissemination of knowledge will also vary across scales, that is, from the local level where participatory approaches are used to incorporate indigenous knowledge and build collective ownership of knowledge generated, to national and broader regional to international levels, thus upholding the principle of subsidiarity in the organization, sharing, and dissemination of information on disaster risk management (Marincioni, 2007; Chagutah, 2009).

An internationally agreed mechanism for acquisition, storage and retrieval, and sharing of integrated climate change risk information, knowledge, and experiences is yet to be established (Sobel and Leeson, 2007). Where this has been achieved it is fragmented, assumes a top-down approach, is sometimes carried out by institutions with no clear international mandate, and the quality of the data and its coverage are inadequate. In other cases a huge amount of information is collected but not efficiently used (Zhang et al., 2002; Sobel and Leeson, 2007). Access to data or information under government institutions is often constrained by bureaucracy and consolidating shared information can be hampered by multiple formats and incompatible data sets. The major challenge in achieving coordinated integrated risk management across scales is in establishing clear mechanisms for a networked program to generate and exchange diverse experiences, tools, and information that can enable various DRR and CCA actors at different levels to use different options available for reducing climate risks. Such a mechanism will support efforts to mainstream CCA and DRR into development, for example, in the case of initiatives by UNDP; development organizations such as the World Bank, DFID, and the IADB; the Canadian International Development Agency; the European Commission; and so forth (Benson and Twigg, 2007). Accounting for climate risks within the development context will, among other things, be effectively achieved where appropriate information and knowledge of what is required exist and are known and shared efficiently (Ogallo, 2010).

7.4.5.1. Knowledge Acquisition

Knowledge acquisition by nature is a complex, continuous, nonlinear, and life-long process that spans generations. Knowledge acquisition for DRR and CCA involves acquisition, documentation, and evaluation of knowledge for its authenticity and applicability over time and beyond its point of origin (Rautela, 2005). Knowledge acquisition and documentation has to focus on the shifting emphasis by the HFA from reactive emergency relief to proactive DRR approaches by aiming at strengthening prevention, mitigation, and preparedness and linking with changes in CCA that include greater focus on local scales (refer to Section 7.4.3.2). The Global Spatial Data Infrastructure (GSDI), which aims to coordinate and support the development of Spatial Data Infrastructures worldwide, provides important services for a proactive DRR approach (Köhler and Wächter, 2006). One of the major breakthroughs facilitating the creation of the GSDI has been the development of interoperability standards and technology that form a common foundation for the sharing and interoperability of, for example, geospatial data. However, global geospatial data infrastructure is still largely underutilized for site- and/or application-specific needs (Le Cozannet et al., 2008; Di and Ramapriyan, 2010).

There are huge efforts in DRR- and CCA-related knowledge acquisition, development, and exchange by universities, government agencies, international organizations, and to some extent the private sector, but coordination of these efforts internationally is yet to be achieved (Marincioni, 2007). At the international level, the International Council for Science (ICSU) is the main international body that facilitates and funds efforts to generate global environmental change information that extends into DRR and CCA. ICSU is an NGO with a global membership of national scientific bodies (121 members) and international scientific unions (30 members) that maintain a strong focus on natural sciences (www.icsu.org). However, there have been changes over the years and ICSU now works closely with the International Social Science Council (ISSC). There are four major global environmental change (GEC) research programs facilitated by ICSU: an International Programme of Biodiversity Science (DIVERSITAS), the International Geosphere Biosphere Programme, the International Human Dimensions Programme closely tied to the ISSC, and the World Climate Research Programme. These programs have been supported by a capacity-building and information dissemination wing, the System for Analysis, Research and Training. The four GEC programs have had a significant role in generating the background science that forms the basis for CCA and DRR (Steffen et al., 2004). The link between science and policy within the UN system for CCA is achieved through the IPCC process while for DRR it is through activities of the UNISDR.

There has been growing concern that GEC programs are not integrated and provide fragmented information limited to certain disciplines. This concern led to the establishment of the Earth System Science Partnership aiming to integrate natural and social sciences from the regional to the global scale. However, this has proved inadequate to meet the growing need for integrated information (Leemans et al., 2009). As a result, a major restructuring of the knowledge generation process both at the institutional and science level has been launched by ICSU and the main focus is on increased use of integrated approaches and co-production of knowledge with potential users to deliver regionally and locally relevant information to address environmental risks for sustainable development. These initiatives will influence the process of integration of DRR and CCA and their linkages to development in the future (ICSU, 2010; Reid et al., 2010).

An assessment of climate services for DRR and CCA is given in Section 7.3.3.2. But the generation of climate change information has followed a top-down approach relying on global models to produce broad-scale information with no clear local context and usually with large uncertainties and complex for the public to assimilate hence providing lower incentive for policymakers to act on the risks that are indicated (Weingart et al., 2000; Schipper and Pelling, 2006). Climate change information is primarily provided at long temporal ranges, for example, 2050, which is far beyond the usual five-year attention span of most political governments let alone that of poor people concerned with basic needs. Climate information at all scales is essential for decisionmaking although there are various factors other than climate information that ultimately influence decisionmaking. The IPCC Fifth Assessment Report will cover near-term climate extending to periods earlier than 2050. Efforts to enhance delivery of information at interannual to interdecadal scales will improve assimilation of climate information in risk management (Goddard et al., 2010; Vera et al., 2010). However, expressing impacts, vulnerability, and adaption require description of complex interactions between biophysical characteristics of a risk and socioeconomic factors and relating to factors that usually span far beyond the area experiencing the risk. Communicating these linkages has been a challenge particularly for areas where education levels are low and communication infrastructure is inadequate (Vogel and O'Brien, 2006).

Knowledge acquisition and documentation requires capacity in terms of skilled manpower, infrastructure, and appropriate institutions and funding (Section 7.4.3.1). Long-term research and monitoring with a wide global coverage of different hazards and vulnerabilities is required (Kinzig, 2001). For example, forecasting a hazard is a key aspect of disaster prevention but generating such information comes with a cost. Although weather forecasting through the meteorological networks of WMO is improving, the network of meteorological stations is far from spatially adequate and some have ceased to operate or are not adequately equipped (Ogallo, 2010). Forecasters are challenged to communicate forecasts that are often characterized by large uncertainty but which need to be conveyed in a manner that can be readily understood by policymakers and the public (Vogel and O'Brien, 2006; Carvalho, 2007).

Interdisciplinary generation of information – that is, bridging the traditional divide among the social, natural, behavioral, and engineering sciences – continues to be a great intellectual challenge in climate change risk reduction. The newly formed Integrated Research on Disaster Risk (IRDR) program – co-sponsored by ICSU, ISSC, and UNISDR – aims at applying an integrated approach in understanding natural and human-induced environmental hazards (ICSU, 2008; McBean, 2010). IRDR is intended to address these challenges and gradually provide relevant data, information, and knowledge on vulnerability trends, which are key information for policy- and decisionmakers to formulate integrated policies and measures for DRR and CCA.

7.4.5.2. Knowledge Organization, Sharing, and Dissemination

Exchange of disaster information worldwide has increased tremendously through, for example, mass media and information and communication technologies (ICT). The role of mass media in addressing the broader needs of DRR and CCA as opposed to disaster response is still limited, although various regional initiatives such as the Network of Climate Journalists of the Greater Horn of Africa (NECJOGHA) that involve climate and media experts are being established to improve the situation (Ogallo, 2010). NECJOGHA serves to disseminate integrated information based on, for example, environmental monitoring, climatology, agronomy, public health, and so forth, to the users to enhance sustainable response to climate change. Clearly, multiple strategies for disseminating and sharing knowledge and information are required for different needs at different scales (Glik, 2007; Maitland and Tapia, 2007; Maibach et al., 2008; Saab et al., 2008; see also Chapters 5 and 6). In particular, greater efforts are needed to identify and communicate information on vulnerability development, going beyond and adding to the hazards information, to effectively contribute to reducing risk.

Disaster response and recovery are closely linked to provision of effective communication prior to and throughout the disaster situation (Zhang et al., 2002). Mass media, for example, radio, television, and newspapers are powerful mechanisms for conveying information during and immediately after disasters although they may over-sensationalize issues, which may influence perception of risk and subsequent responses (Vasterman et al., 2005; Glik, 2007). A 'two-step flow' approach where the mass media is combined with interpersonal communication channels has been found to provide a more effective approach to information dissemination (Maibach et al., 2008; Chagutah, 2009; Kaklauskas et al., 2009).

Increased use of ICT such as mobile phones, online blogging websites with interactive functions and links to other web pages and real-time crowd-sourcing electronic commentary, and other forms of web-based social-networked communications such as Twitter, Facebook, etc., represent current tools for timely information dissemination. They facilitate rapid exchange of information, for instance, from the disaster scene to rescuers and/or delivery of vital information to those affected. This is particularly the case where such information is given in an appropriate format and language and facilities to deliver information are accessible (Glik, 2007). There are emerging attempts to develop mobile phone-based disaster response services, for example, that can translate disaster information into different languages (Hasegawa et al., 2005); and use real-time mobile phone-calling data to provide information on location and movement of victims in a disaster area (Madey et al., 2007). Mobile phones are now routinely used to disseminate disaster warning information within industrialized countries and the process is rapidly expanding to developing countries.

Information sharing and dissemination for disaster relief has improved through the establishment of the ReliefWeb site (www.reliefweb.int) by the UN Office for the Coordination of Humanitarian Affairs (OCHA) in 1996. ReliefWeb so far offers the largest Internet-based international disaster information gathering, sharing, and dissemination mechanism (Wolz and Park, 2006; Maitland and Tapia, 2007; Saab et al., 2008). The International Charter (www.disasterscharter.org) provides space data that serve to augment the ReliefWeb. But the OCHA ReliefWeb does not cover preparedness and disaster prevention to fully embrace CCA and DRR compared to the comparatively more recent PreventionWeb (www.preventionweb.net) where disaster risk reduction is covered.

Despite the growing role of mass media and ICT in disaster response, significant improvements are still needed to reduce disaster losses. The full potential of mobile phones and Internet facilities in disaster relief has yet to be exploited. The OCHA ReliefWeb poorly represents local- to national-level humanitarian activities; for example, most of this information is not translated into different languages (Wolz and Park, 2006). There are large sections of the global population who have no access to Internet and other telecommunication services (Samarajiva, 2005) although evidence shows that improved access by disaster workers has overall positive effects on disaster relief (Wolz and Park, 2006). Other initiatives such as RAdio and InterNET (RANET), a satellite broadcast service that combines radio and Internet to communicate hydro-meteorological and climate-related information, are examples of innovative measures being put in place to address the problem of limited access to the Internet in developing countries (Boulahya et al., 2005). Sustainable use of ICT for coordination of information for humanitarian efforts faces challenges of limited resources to mount, maintain, and upgrade these systems (Saab et al., 2008). ICT is also limited to explicit knowledge that is comprised of, for example, documents and data stored in computers but generally lacks tacit knowledge that is based on experience linked to someone's expertise, competence, understanding, professional intuition, and so forth that can be valuable for disaster relief (Kaklauskas et al., 2009). Increased international collaboration on disaster management and also the growing use of interactive web communication facilities provides for the filtering of tacit knowledge.

7.4.5.2.1. Disaster risk reduction and climate change adaptation

In addition to disaster management organizations such as UNISDR, the International Federation of Red Cross and Red Crescent Societies, the Federal Emergency Management Agency, national Red Cross and Red Crescent societies, and so forth, a great deal of knowledge dissemination is accomplished in the academic field. But this knowledge does not translate automatically to the general public. The use of ICTs such as computer networks, digital libraries, satellite communications, remote sensing, grid technology, and GIS for data and information integration for knowledge acquisition and exchange is growing to be important in integrating DRR and CCA (UNISDR, 2005b; Louhisuo et al., 2007; see also Section 7.4.3.2). ICT offers interactive modes of learning that could be of value in distance education and online data sharing and retrieval. For example, the Centre for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Louvain in Belgium maintains the Emergency Events Database (EM-DAT), which has over 18,000 entries on disasters in the world dated from 1900 to present (www.cred.be). The data are recorded on a country-level basis and form a useful resource for disaster preparedness and vulnerability assessments, although information on small-scale disasters is difficult to establish (Tschoegl , 2006). In addition to CRED, a comprehensive database of global natural catastrophe losses is provided by the Munich Re NatCatSERVICE, where nearly 800 events are entered in the database every year; by 2009, the database had more than 25,000 entries with losses spanning from the 1980s, although records for major events go up to 2000 years ago (Schmidt et al., 2009; Zschocke and de Leon, 2010). Because of its strong focus on insured losses, the Munich Re database tends to have less coverage for areas with lower insurance coverage. At a regional level, the DesInventar database in Latin America is an example of a regional database that was developed in 1994 by the Network for Social Studies in Disaster Prevention. The DesInventar database is an inventory of small-, medium-, and greater-impact disasters (www.desinventar.net) and aims to facilitate dialog for risk management between actors, institutions, sectors, and provincial and national governments. This initiative has been extended to the Caribbean, Asia, and Africa by UNDP, while the UNFCCC provides a more local-scale database on local coping strategies (maindb.unfccc.int/public/adaptation).

ICT capabilities in disaster risk reduction also lie in enhancing interaction among individuals and institutions from the national, to regional, to international level, for example, through e-mail, newsgroups, online chats, mailing lists, and web forums (Marincioni, 2007). Attempts have been made, for example, in Japan, to create an integrated disaster risk reduction system where mobile phone communication operates as part of a greater information generation and delivery chain that includes Earth observation data analysis, navigation and web technologies, GIS, and advanced information technology such as grid (Louhisuo et al., 2007). When such innovations are transferred to other regions they contribute to international DRR efforts.

Other initiatives include NetHope International, which combines development and disaster issues into its ICT-centric mandate (Saab et al., 2008). RANET (www.oar.noaa.gov/spotlite/archive/spot_ranet.html), originally developed in Africa for drought and which spread to Asia, Pacific, Central America, and the Caribbean, has a strong community engagement and disseminates comprehensive information from global climate data banks combined with regional and local data and forecasts resulting in spinoffs to food security, agriculture, and health in rural areas (Boulahya et al., 2005). A network of extension agents, development practitioners, and trained members of the community are used in RANET to translate information into local contexts and languages and as a result, RANET is being considered for other educational initiatives such as the Spare Time University to improve access to learning in DRR with benefits for CCA (Glantz, 2007). RANET has been found to reduce vulnerability to climate extremes in different areas in Africa, for example, communication of rainfall forecasts in parts of west Africa assists farmers with decisions on what crop variety to plant and field to use where a choice of fields of different soil type existed, and also where to search for pasture and water for livestock during drought periods. However, RANET faces challenges of unavailability of technical support, follow-up training, power supply, and coordination (Boulahya et al., 2005).

The establishment of the PreventionWeb facility by UNISDR demonstrates the potential of ICT in information sharing for international disaster risk management across scales. PreventionWeb has been evolving since 2006, and was built on the experience of ReliefWeb with the purpose of becoming a single entry point to the full range of global disaster risk reduction information and providing a common platform for institutions to connect, exchange experiences, and share information on DRR, and facilitating integration with CCA and the development process. Updated daily, the PreventionWeb platform contains news, DRR initiatives, event calendars, online discussions, contact directories, policy and reference documents, training events, terminology, country profiles, and fact sheets as well as audio and video content. Hence, while catering primarily to DRR professionals, it also promotes better understanding of disaster risk by non-specialists. PreventionWeb is a response to a need for greater information and knowledge sharing and dissemination advanced in Zhang et al. (2002), Marincioni (2007), Kaklauskas et al. (2009), and others. The web site serves a critical role in supporting the implementation of the HFA where information and knowledge sharing is essential (Zschocke and de Leon, 2010). But the full potential of PreventionWeb has yet to be realized and evaluated since it is a relatively new initiative.

In addition to the PreventionWeb with a DRR focus, the number of web-based resource portals supporting both DRR and CCA has been increasing. These include, among others, ProVention Consortium, which had a DRR and climate focus (www.proventionconsortium.org) but has ceased to operate; the UN Adaptation Learning Mechanism (www.adaptationlearning.net) with links to related online resources and documentation of over 140 countries; Linking Climate Adaptation Network/CBA-X (www.linkingclimateadaptation.org) which has some DRR focus, had over 1,000 members in 2008, and has continued to provide current thinking on climate adaptation and resources and publications for researchers, practitioners, and policy formers; and the WeAdapt/WikiAdapt, an adaptation focus portal (www.weadapt.org) that goes beyond networking and dissemination to cover knowledge integration and other innovative adaptation tools. These portals are relatively new, remain predominantly used by their respective communities, and have also been noted by others to be poorly organized (Mitchell and van Aalst, 2008). Performance of such ICT information resources in disaster risk management could improve with more coordination and integration of CCA, DRR, and the development community.

7.4.5.2.2. Constraints in knowledge sharing and dissemination

For all information tools noted, the quality of information transferred and language used influence their effectiveness. Further, these mechanisms often collapse during a disaster when most needed (Marincioni, 2007; Saab et al., 2008). Some of the new technologies are not easily accessible to the very poor, and even the most innovative tools like RANET show numerous maintenance constraints particularly in remote areas (Boulahya et al., 2005).

There are differences in perception on the role of ICT in the exchange of disaster and hazard risk knowledge as opposed to its role in increased flow of information, with knowledge here defined simply as understanding of information while information refers to organized data (Zhang et al., 2002; Marincioni, 2007). Indications are that, while there is increased circulation of disaster information, this does not always result in increased assimilation of new risk reduction approaches, a factor that is partly attributed to lack of effective sharing although lack of capacity to use/apply the information could be a major factor (Zhang et al., 2002; UNISDR, 2005b).The level of assimilation of ICT technology into disaster risk reduction depends, among other things, on levels of literacy and the working environment including institutional arrangements, hence effectiveness may vary with levels of development (Samarajiva, 2005; Marincioni, 2007; see also Section 7.4.3.2). As a result, the contribution of these relatively new facilities such as PreventionWeb will, among other things, depend on accessibility and assimilation of ICT in the daily operations of institutions across the globe. Evidence shows that information alone is not adequate to address disaster risk reduction; rather, other factors such as availability of resources, effective management structures, and social networks are critical (Glik, 2007; Lemos et al., 2007; Maibach et al., 2008; Chagutah, 2009).

A major constraint in climate change risk management results from the fact that communities working in disaster management, climate change, and development operate separately and this increases vulnerability to climate extremes leading to disasters (Schipper and Pelling, 2006; Lemos et al., 2007). For example, emphasis on humanitarian assistance has been attributed to development agendas that do not adequately integrate risk reduction leading to increased vulnerability (Benson and Twigg, 2007), while development community members are, for example, better equipped with the use of insurance but fail to link this to climate risk reduction thus exposing communities to vulnerability to climate extremes. Similar observations have been made about cities where urban developers have no link with the climate risk management community (Wamsler, 2006). But in fact both the development and climate adaptation communities are concerned with vulnerability to disasters. This could be a common point of focus facilitating collaboration in research, information sharing, and practice as part of global security (Schipper and Pelling, 2006; Lemos et al., 2007).

Communication gaps between professional groups often result from different language styles and jargons. Heltberg et al. (2008) have suggested a need for establishing universally shared basic operational definitions of key terms such as risk, vulnerability, and adaptation across the different actors as a basis for dissemination of knowledge. This has also been noted by others, for example, for better coordination among numerous humanitarian organizations (Saab et al., 2008) and in the FAO guide for disaster risk management (Baas et al., 2008; also see Chapter 1). The move toward establishment of national disaster risk reduction institutions that link to similar regional and international structures by, for example, UNISDR, provides a framework for bringing different stakeholders together including the climate change and development communities at the national level, culminating in greater integration of risk management at the international level. Other efforts include international initiatives to integrate, at the national level, disaster risk reduction with poverty reduction frameworks (Schipper and Pelling, 2006).

In conclusion, there is *high agreement* in the literature indicating that efforts are being made internationally to build information and knowledge bases that support the shift in emphasis by the HFA from reactive emergency relief to proactive DRR (*high confidence*). Conventional media and ICT are major factors in facilitating the required international exchange and dissemination of information on disaster response, CCA, and DRR (*high confidence*). This in turn stimulates generation of new knowledge and will over time lead to greater integration of DRR and CCA, which at the present moment is still limited (*medium confidence*). The limitation of relying heavily on ICT is that there is still a large part of the world where the ICT infrastructure is not adequately developed. There is also *high agreement* in the literature that an increase in the exchange of data and information at the international level on its own is not a complete solution to risk reduction. Resources to generate and supply information and experience in a usable form for each unique case so as to translate this to knowledge and action are a critical dimension in risk reduction (*high confidence*). Further, more attention is required for the international community to identify what information is essential for different stages of climate change risk management, and how it should be captured and used by different actors under different risk reduction scenarios. Data gathering, information, and knowledge acquisition and management for disaster relief has a longer history. The process of building integrated information resource tools that brings together experiences from CCA, DRR, and the development community is still weak, yet these tools hold the promise for reducing vulnerability to disasters in the future (*high confidence*).

7.5. Considerations for Future Policy and Research

How best can experience with disaster risk reduction at the international level be used to help or strengthen climate change adaptation? The characteristics of the DRR regime (as exemplified chiefly by the UNISDR and the Hyogo Framework for Action) and the CCA regime (chiefly the UNFCCC and the IPCC) have been described in detail and assessed to the extent that the literature allows. One frequently made assumption is that the DRR world has much to learn from CCA and vice versa (IPCC, 2009). It is widely proposed in the literature that disaster risk reduction and climate change adaptation should be 'integrated' (Birkmann and von Teichman, 2010).

The call for integration of disaster risk reduction with climate change adaptation goes much further, however (UNISDR, 2009a). It is argued that both disaster risk reduction and climate change adaptation remain outside the mainstream of development activities (UNISDR, 2009a). The United Nations Global Assessment Report on Disaster Risk Reduction calls for "an urgent paradigm shift" in disaster risk reduction to address the underlying risk drivers such as vulnerable rural livelihoods, poor urban governance, and declining ecosystems (UNISDR, 2009a). The report also calls for the harmonization of existing institutional and governance arrangements for disaster risk reduction and climate change adaptation (p. 181), and presents a 20-point plan to reduce risk (pp. 176-177).

These conclusions come from an official UN report (UNISDR, 2009a), and they are widely supported in the scientific literature (O'Brien et al., 2006; Schipper, 2009) as well as in other government reports (DFID, 2005; Birkmann et al., 2009; CCD, 2009) and in the advocacy literature (Venton and La Trobe, 2008). More recently, the widely reviewed ICSU (2010) report (called the Belmont Challenge) on Regional Environmental Change: Human Action and Adaptation, which was commissioned by the major global environmental change research funders to assess the international research capability required to respond to the challenge of delivering knowledge to support human action and adaptation to regional environmental change, concluded by calling for a highly coordinated and collaborative research program to deliver integrated knowledge required to identify and respond to hazards, risks, and vulnerability, and develop mitigation and adaptation strategies. Similarly, ICSU and the ISSC carried out a wide consultative process to rethink the focus and framework of Earth system research. This consultation came out with four Grand Challenges that require a balanced mix of disciplinary and interdisciplinary research to address critical issues at the intersection of Earth systems science and sustainable development (Reid et al., 2010):

- Improve the usefulness of forecasts of future environmental conditions and their consequences for people.
- Develop, enhance, and integrate observation systems to manage global and regional environmental change.
- Determine how to anticipate, avoid, and manage disruptive global environmental change.
- Determine institutional, economic, and behavioral changes to enable effective steps toward global sustainability.

Both the Belmont Challenge and the Grand Challenges are setting an international tone for an integrative approach to challenges such as DRR, CCA, and development. There is no shortage of policy proposals designed to integrate disaster risk reduction and climate change adaptation for their common strengthening and benefit.

Official reports also list many reasons why more movement in this direction has been slow to develop. One constraint is the difficulty of integration across scales, which is addressed in Section 7.6. Two other sets of constraints are described as 'the normative dimension' and 'the knowledge dimension' (Birkmann et al., 2009). The extensive list of challenges and constraints identified includes the following:

- *Normative Dimensions* (adapted from Birkmann et al., 2009)
  - Absence of uniform methods, standards, and procedures in vulnerability and capacity assessment and also in the design, formulation, and implementation of adaptation plans, programs, and projects. Lack of clear norms when applying vulnerability and capacity assessment and when designing and implementing adaptation measures
  - The desire for stability and the tendency to rapidly restore normalcy limit the scope to explore and to take advantage of the opportunity after disaster and recover in an adaptive way by taking account of future climate change. The notion and desire for stability may hamper the chance to take advantage of change and dynamics – after disasters, the chance to use the opportunity and build back in an adaptive way considering future climate change is in most cases not taken – more commonly, infrastructure is rapidly built back to the pre-disaster condition
- *Knowledge Challenges* (adapted from Birkmann et al., 2009)
  - Differences in the form of terminology used – that is, the different terms and definitions framed by both DRR and CCA communities
  - Unavailability of information about the concrete effects of climate change at the local level (see Section 7.4.5.1)
  - Limited census-based information on relevant census data (social and economic parameters) especially in dynamic areas with, for example, high fluctuations of people and/or economic instability
  - Scientific knowledge on climate change acquired by the scientific community has not been translated or trickled down to practitioners or it is communicated in a way that is hard to understand and derive practical knowledge (see Section 7.4.5.2.2)
  - Absence or lack of appropriate indicators for assessment that could measure successful adaptation and which could also be incorporated into funding guidelines as well as monitoring and evaluation strategies (ICSU, 2010).

For the purposes of this Special Report, the question has been formulated in terms of what can be learned from the practice of DRR to advance CCA. It is clear from the literature, however, that cooperation between the DRR and CCA communities is a two-way process. This has given rise to questions about how 'integration' in practice at local and national levels might best be facilitated by change at the international level.

7.6. Integration across Scales

7.6.1. The Status of Integration

The literature reflects three different perspectives on the integration of disaster risk reduction and climate change adaptation. One view common among the community of experts and practitioners is that climate change adaptation should be integrated into disaster risk reduction (CCD, 2008a,b,c; Prabhakar et al., 2009, p. 26). It has even been suggested that climate change adaptation is a case of 'reinventing the wheel' (Mercer 2010) since disaster risk reduction covers much of the same ground and is "already well-established within the international development community" (Lewis, 1999; Wisner et al., 2004). Practitioners in disaster risk reduction tend to have the view that climate change is one of a number of factors contributing to vulnerability and disasters (Mercer, 2010), and that therefore climate change adaptation needs to be taken on board.

A second view is adopted by many in the climate change adaptation community. They recognize a diversity of cross-cutting risks that can be associated with the impacts of climate change and consider disaster risk to be one of these (Birkmann and von Teichman, 2010). They conclude that disaster risk reduction should be integrated into climate change adaptation.

A third and perhaps more widespread view is that both disaster risk reduction and climate change adaptation should be more effectively integrated into wider development planning (Glantz, 1999; O'Brien et al., 2006; Lewis, 2007; CCD, 2009; Christoplos et al., 2009; UNISDR, 2009a).

At the practical level there are many steps already underway to bring about such forms of integration (see Chapters 5 and 6). There are numerous hazards and disasters that are not directly linked to climate change but their impacts may serve to increase vulnerability to climate change. Nevertheless, as noted in Section 7.5 there are many obstacles to integration and it is by no means agreed that full integration between disaster risk reduction and climate change adaptation is possible, or desirable.

The potential benefits as well as the obstacles to integration can be examined in terms of three scales: the spatial, the temporal, and the functional (Birkmann and von Teichman, 2010).

7.6.2. Integration at a Spatial Scale

The literature reflects a view that DRR and CCA operate at different spatial scales (Birkmann and von Teichman, 2010) and that therefore their integration in practice has been problematic or impracticable. Disasters are often thought of as events occurring at a specific location whereas climate change is thought of as a global or regional phenomenon. This view is now being modified as the need for locally based climate change adaptation becomes evident (Adger et al., 2005), as the impacts of local disasters are recognized as having more widespread impacts at a larger spatial scale (see Chapters 4 and 6 and Section 7.2.1).

One commonly cited impediment to integration is that climate change projections do not provide precise information at a local scale (see Chapter 3) and that adaptation strategies tend to be designed for entire countries or regions (German Federal Government, 2008; Red Cross and Red Crescent Climate Centre, 2007).

7.6.3. Integration at a Temporal Scale

There is also a perceived difference in the temporal scales of CCA and DRR. The disaster community has traditionally been focused on humanitarian response including relief and reconstruction in the relatively short term. (UNISDR, 2009b), whereas climate change has been recognized as including long-term processes with projections extending from decades to centuries (Chapter 3), which poses problems for development communities usually focusing on a shorter time span. More effective cooperation and integration between the DRR and the CCA practitioners could help to detect, address, and overcome these temporal-scale challenges. This essentially requires the stronger recognition of the risks of climate-related disasters in CCA and the incorporation of longer-term climate change risk factors into DRR.

7.6.4. Integration at a Functional Scale

The functional separation of CCA and DRR institutions, organizations, and mechanisms extends across all three levels of management from local to national to international. At the international level there are weak links between the climate adaptation 'regime' as expressed in the UNFCCC and the leading DRR 'regime' in the form of the UNISDR. The character of the two 'regimes' is radically different, the former having the task of implementing an international agreement and the latter being a UN-wide interagency and advocacy program. The history of the evolution of the two institutional arrangements is markedly different. The disaster field has long been dominated by humanitarian and emergency response measures and has only relatively recently been moving toward a stronger DRR approach (Burton, 2003). Similarly, climate change was initially conceived as an atmospheric pollution issue with greater emphasis on the need to reduce greenhouse gas emissions and has slowly been repositioned, as in the UNFCCC negotiations, as also being a development issue. One consequence of the different evolution has been that the emerging international climate 'regime' (UNFCCC) is linked at the national level to environment ministries, whereas the disaster 'regime' (UNISDR) is linked to emergency planning and preparedness agencies or, in other cases, to the office of President. Neither DRR nor CAA are well linked to economic planning and development agencies (UNISDR, 2009b).

There is also a 'top-down' versus 'bottom-up' distinction (Rayner, 2010). Natural hazards and associated disasters have a long history, and DRR has moved slowly from local to national to international levels in response to the rationale described in Section 7.2. Climate change, on the other hand, came to attention as a result of the work of atmospheric scientists and was first recognized primarily as a global problem, and has subsequently moved down scale as the need for CCA became more apparent and pressing. This shows that the opportunity exists for the two to complement each other, at the international level where DRR has progressed, and at the national and local level to which CCA is moving.

7.6.5. Toward More Integration

The mandate of this Special Report is in part to consider how CCA could be enhanced by learning from the experience of the DRR community, and vice versa. The literature shows a widespread view that the two could both benefit from closer integration with each other and that both would benefit society better if there was more integration into sustainable development (UNISDR, 2009a). Integration in this sense is meant as symbiosis or synthesis rather than formal integration at the institutional level. Integration across scales can be facilitated if integration between DRR and CCA were also to take place at local, national, and international levels. Integration at the international level might help to facilitate integration at national and local levels although the opposite is also possible. This Special Report is itself a prime example of emerging cooperation. It is in line with a wider evolution in the global environmental change science research community whose products serve both disaster risk reduction and climate change adaptation at the international level of management.

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