Chapter 7. Managing the Risks: International Level and Integration Across Scales

Coordinating Lead Authors
Ian Burton (Canada), Pauline Dube (Botswana)

Lead Authors
Joanne Bayer (USA), Diarmid Campbell-Lendrum (Switzerland), Ian Davis (UK), Richard J.T. Klein (Sweden), Apurva Sanghi (USA), Ferenc Toth (Austria)

Review Editors
Joy Jacqueline Pereira (Malaysia), Linda Sygna (Norway)

Contributing Authors
Neil Adger (UK), Thea Dickinson (Canada), Kris Ebi (USA), Tarik Islam (Canada, Bangladesh), Clarisse Kehler Siebert (Sweden)

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Executive Summary

There are many organizations working at the international level to manage climate change and disaster risks. An assessment of the activities of all these organizations and how they work together is beyond the scope of this chapter. The focus of this chapter concentrates on the two main institutional arrangements for risk management at the intergovernmental level; that is the International Strategy for Disaster Reduction (ISDR) with its Hyogo Framework for Action (HFA), and the United Nations Framework Convention on Climate Change (UNFCCC). These are two quite different types of institutions; ISDR is an inter-agency strategy with a secretariat while the other is an international treaty.. Both are assessed in terms of their role in the international regimes for DRR and CCA respectively, and in the context of international development, especially as manifested in the Millennium Development Goals. Brief descriptions of the contributions of some selected other programmes and institutions are provided.

Although the mandate of this chapter and of the Special Report as a whole is to answer the question of how CCA might benefit from the experience of DRR it is clear from the literature reviewed that both might benefit from each other in a mutually supportive and synergistic way. From the perspective of many in the DRR management community, CCA should be factored into all disaster risk management. From the perspective of many in the CCA management community, weather-related disasters are or should be an important part of the adaptation agenda. Both these perspectives can be encompassed in a view that argues for closer integration at the international level between DRR and CCA, and that both should be brought more into the mainstream of international development and development assistance. There is a widespread recognition (especially in inter-governmental reports) that neither DRR nor CCA are well enough integrated into current development policies and practices (7.1.1).

Much of the literature tends to view disasters as localized and short-term events. Disaster risk management is often seen as a bottom-up process which begins at a disaster site with events on the ground and hence a matter first of local concern, then national and only international as a last resort, especially in terms of humanitarian assistance and emergency response. By contrast climate change has emerged as a top-down issue identified by science rather than by events, and in terms of first an international concern with the global common property of the atmosphere, being subject to long-term anthropogenic forcing.

These conceptions and perceptions are now changing more or less rapidly. Disasters are increasingly coming to be recognized as having spatially widespread causes and consequences. Global development patterns can help to increase vulnerability and create disasters. Large disasters themselves can have extra-territorial, regional and sometimes global consequences (systemic risks), linked to global security (7.2.1). As adaptation has gained in prominence in the climate negotiations the agenda has become increasingly concerned with adaptation at the local level, as well as with the broader strategic and developmental aspects of adaptation policy and strategy.

Both DRR and CCA involve questions of economic efficiency (7.2.2); solidarity (7.2.3) and subsidiarity (7.2.4); and changing international legal obligations and responsibilities (7.2.5). These elements of the rationale for international management action are assessed early in the Chapter, (7.2) and together with an analysis of existing inter-governmental institutions (focussing on ISDR and UNFCCC in 7.3) provide the basis for the conclusion that both DRR and CCA would be more effective if their institutional management were more closely integrated together and with sustainable development.

There are current strengths and weaknesses in the management of DRR and CCA and five major dimensions are selected for examination of constraints and opportunities at the international level. These are: international law, financing, technology transfer and cooperation, risk sharing and transfer, and knowledge creation, management and dissemination (7.4).

International law evolves slowly and is less advanced in DRR and CCA than in other related fields such as international humanitarian law. Broadening the scope of humanitarian law has been proposed, (and opposed) as an alternative to the further development of international law for DRR and CCA. The emerging legal doctrine of "responsibility to protect" has been proposed in application to natural disasters, and this has some similarity to the UN formulation of "common but differentiated responsibilities" in the Climate Convention (7.4.1).

Under the UNFCCC there is an obligation on developed country parties to assist the most vulnerable countries in meeting costs of adaptation. Several funds have been created under the Global Environment Facility and the Convention and more are in prospect. There is an expectation that a considerably larger fund (the Green Climate Fund) will be created and that within a decade tens of billions of dollars will be made available to support adaptation. There is no such fund available or in prospect for DRR, although CCA funds can, if closely integrated with DRR and development help to reduce vulnerability to disaster risks as well as climate change. Steps in this direction would be in conformity with the Paris Declaration for Aid Effectiveness including principle (c) which specifies "harmonization through simplified and common procedures and shared analysis". As another source of support for DRR it has been proposed that a portion of the internationally donated humanitarian disaster relief funds might be allocated to longer-term disaster prevention, which would also bring DRR into closer alignment with CCA (7.4.2).

There has been much attention to technology transfer and cooperation under the UNFCCC, although until recently this has focussed more on the reduction of GHG emissions than adaptation. There is also considerable attention to technology for disaster risk management, especially to advance and strengthen forecasting and warning systems and emergency response. These activities that are promoted through the HFA are widely dispersed among many international and national-level organizations and not closely linked to ISDR (7.4.3 and 7.4.5).

International risk sharing and transfer is a relatively new and expanding area of cooperation involving both CCA and DRR. Remittances; post-disaster credit; and insurance and reinsurance all have an established role in disaster response. Partly as a result of the concerns about climate change some alternative insurance instruments are in various stages of development and expansion including international risk pools, and micro-insurance. These processes and products are being developed by international financial institutions largely outside the purview of ISDR and the UNFCCC (7.4.4).

There is a substantial growth in research (knowledge generation) and its dissemination in relation to CCA encouraged and facilitated by the UNFCCC and also taking place spontaneously in many research institutions and programmes. Undoubtedly some of this is of benefit to DRR. New mechanisms of knowledge sharing, higher education and training using new technologies such as ICT are also being established at a rapid rate but these need to be coordinated to bring strong linkages between DRR, CCA and development issues (7.4.5).

The agenda for future policy development and research on DRR and CCA is very large, and is being addressed on many fronts both within and beyond the ISDR and the UNFCCC. The prospect of considerably expanded support for CCA is helping to promote a movement towards the closer integration of CCA with DRR and the mainstreaming of both into sustainable international development (7.5). Stronger financial support will facilitate progress in knowledge generation and dissemination; international risk sharing and transfer and technology development and transfer.

While there are grounds for cautious optimism one lesson from DRR to CCA is that stronger efforts at the international level do not necessarily translate to net progress on the ground. Much depends on how international efforts are integrated with the national and local levels. The considerable expansion of DRR through the International Decade for Natural Disaster Reduction (1991-2000) and the establishment of the ISDR have had mixed results – achieving some reduction in mortality and morbidity, and having much less success in the area of economic losses. The problems of disaster risk have continued to grow due to the relentless expansion in exposure and vulnerability even as the international management capacity has expanded. It is a race against time.

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. (Refer to 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 theoretical possibilities or probabilities (IPCC 1990, 1995, first and second assessment reports) and subsequently confirmed as "unequivocal" (IPCC 2007 4th assessment report).

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 (adapted at the 13th Session of the Conference of the Parties to the UNFCCC (UNFCCC, 2007).

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 climate change and its associated changes in variability and extremes. A frequently posed question therefore asks how the comparatively new field of climate change adaptation can benefit from the longer experience in disaster risk management. It is also a major focus of this Special Report.

Although climate extremes have a negative effect they have helped to raise consciousness of climate change within the public and policymakers. This can then help to generate a further sense of legitimacy 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 disaster risk management 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, globalisation and the need to meet MDGs can when combined with mitigation lead to reduced vulnerability (Haines et al., 2006; Adger et al., 2005). The 2007/2008 Human Development Report noted that if climate change is not adequately addressed now 40 per cent of the world's poorest i.e. 2.6 billion people - will be confined to a future of diminished opportunity (Stern, 2006; UNDP, 2007).

The long term potential to reducing exposure to climate risks lies in sustainable development (O'Brien et al, 2008). Although each extends beyond the scope of the other both seek to build resilience through sustainable development (O'Brien et al., 2008).

This recognizes the need for disaster risk management to be a key component in the ongoing climate change negotiations under the UNFCCC and agreed in the Bali Action Plan (UNFCCC, 2007).

Disaster risk management and climate change adaptation could be realised through increased awareness and use of their 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 (WCDR) held in Kobe (UN ISDR, 2005c), Hyogo Prefecture, Japan in 2005 and the Bali Action Plan both point to the need for incorporation of measures than can reduce climate change impacts within the practice of disaster risk reduction. Integration of the relevant aspects of disaster risk reduction and climate change adaptation can be facilitated by using the Hyogo Framework for Action (2005-2015) as agreed by 168 governments in Kobe (UN ISDR, 2005a).

7.1.2. Related Questions and Chapter Structure

Within the context of the overarching question – how can the 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 address 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 and constraints for 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, 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 examines the rationale for DRR and CCA interventions at the international level. Starting from the reality that risks of extreme weather and risk management interventions cross national borders, this section discusses the systemic nature of these risks and their effects on international security before turning to a discussion of the principles of efficiency, solidarity and subsidiarity as they have shaped international discourse, practices and legal obligations and responsibilities 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 inter-dependency, 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. Major interlinked events, such as global sea level rise, will bring not only increased levels of hazard to specific areas, but the initial impacts of such changes can extend to second and third order impacts. This can apply to the contiguous zones of many countries, such as shared basins with associated flood risks, which calls for trans-boundary, international mechanisms. Relationships and connections involving the movement of goods (trade), finance (capital flows and remittances), and people (displaced populations) can have transboundary effects and extend to continents and indeed to the world as a whole. Moreover, actions in one country can have effects on the risks of 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).

Turning specifically to displaced persons, a recent UN report estimated that over 20 million people were displaced by sudden-onset climate-related disasters in 2008 compared to 4.6 million newly displaced because of conflict (Norwegian Refugee Council and Internal Displacement Monitoring Center, 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 such as HIV/AIDS, and conflict (Myers, 2005; Morrissey, 2009; Guzman, 2009; Thomalla et al., 2006; Barnett, and Adger 2007; CIENS, 2007). As opposed to abrupt displacement due to extreme weather events, mobility and migration can also be an adaptation strategy (Barnett and Webber, 2009), although 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 (Heltberg et al, 2008; Morrissey, 2009; Warner et al., 2009). The impact of climate -driven migration on human security including violent conflict, international trade and the overall global economy continues to be a source of concern prompting the need for international intervention (Barnett and Adger, 2007; Heltberg et al., 2008; Kolmannskog, 2008; Warner et al., 2009; Tacoli, 2009).

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 emphasizes the importance of confronting the societal context, including development levels, 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 both equity issues and the growing connections among people and places in coupled social-ecological systems.

7.2.2. Economic Efficiency

The public policy literature sets out principles by which governments should intervene to assist both their citizens and those outside their national jurisdictions to adapt to climate change impacts. Stern (2007), for example, makes the case that adaptation will not happen autonomously because of inefficiencies in resource allocation brought about by missing and misaligned markets ((p. 467). International interventions are thus arguably justified on the basis of the principles of interdependence of the world economy and human security (discussed above) and the public good nature of many risk management actions, for example, implementing regional warning systems and collecting climate data. 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 widely adopted and shared within the literature on international responsibility (Stern 2007, Vernon, 2008; World Bank, 2010; Gupta et al., 2010).

Early warning systems (as an example of a public good) can depend on regional and international cooperation to secure the exchange of necessary data. 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). Much remains to be done to achieve similar levels of agreement in other hazard fields (Basher, 2006).

Another example of economic efficiency justifying the management of risks at an international level is regional risk pooling. By pooling risks across individual countries, regions, and the world, catastrophe insurance pools generate diversification benefits that are reflected in reduced insurance premiums (see Section 7.4), which benefit individuals, development agencies, governments and others paying the upfront costs for catastrophic risk coverage.

7.2.3. Solidarity

It is not only efficiency considerations that justify international interventions, but also solidarity with those least able to cope with the extreme impacts of climate change. 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). Based on this declaration of global solidarity, climate-related risks are part of the "collective responsibility" referred to in the Declaration because poor countries suffer the most in terms of development and human well-being. In the poorest countries, people have a significantly higher chance of dying due to natural disasters, and the economic cost per disaster in terms of GDP is much higher than in OECD countries (Barnett et al, 2008). Increasing frequency, magnitude and spatial coverage of some climate extremes (see Chapter 3) mean losses can exceed the capability of many individual countries to manage the risk (Rodriguez et al, 2009). Many have concluded that the most vulnerable countries will have difficulty in adapting to extreme events and other impacts of climate change without significant international assistance (World Bank, 2010; Klein and Persson, 2008; Klein and Mohner 2009; Agrawala and Fankhauser 2008; Agrawala and van Aalst, 2008; Gupta et al., 2010). Solidarity 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 towards meeting the Millennium Development Goals (MDGs) as expressed in the Millennium Declaration , especially the goal of eradicating extreme poverty and hunger (UNDP, 2002; Mirza, 2003; UNDP, 2007; UN ISDR, 2009a), which can be interpreted as a direct raison d'être for international intervention in risk management (UN ISDR, 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 exposure 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).

Common human concern has been articulated most effectively with regard to post-disaster humanitarian assistance, and the Millennium Declaration gives specific mention to natural disasters in this context. With growing globalisation the principle of solidarity 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. Nations can piggyback a humanitarian effort on top of a for-profit operation involving their companies (Dunfee and Hess 2000). Examples include Johnsons and Johnson's provision of relief to disaster victims and Monsanto's efforts to teach impoverished farmers techniques for growing crops in periods of drought (Dunfee and Hess 2000).

Humanitarian assistance, although essential for upholding solidarity, can lead to emphasizing disaster response strategies at the expense of pro-active integrated approaches to disaster risk reduction (UNDP, 2002). This can have the effect of perpetuating vulnerability (Bhatt, 2007). For this reason, the DRM 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).

Beyond a sense of common human concern, it is argued that countries contributing most to climate change 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 notion of Common but Differentiated

Responsibility (CBDR), which has emerged as a guiding principle of international environmental law (De Lucia, 2007) and has been explicitly formulated in the context of the 1992 Rio Earth Summit.

> "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 anchored in a large literature from law and political science on environmental justice, which examines principles for responsibility for international action and focuses on identifying fairness within such principles (see section 7.2.5). Farber (2007, 2008), Delink et al. (2009) and Grasso (2010) review potential arguments over who is responsible and who should pay for adaptation. From this literature, potential principles for allocation of responsibility have emerged including compensation to the victims a) by the beneficiaries of adaptation b) by governments through an international taxation on the basis of ability to pay; c) by polluters, in this case those who emit greenhouse gases and hence ultimately cause the harm; or d) by those who are 'climate change winners' from the impacts of climate change.

Another set of literature (e.g. Caney, 2010; Adger et al. 2009) 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' (Caney, 2008; Adger, 2004). 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. Climate change impacts jeopardise fundamental rights to life and livelihood (such as impacts on disease burden, malnutrition and food security). Caney (2010) also discusses a right 'not to be forcibly evicted' (p. 83) as a potential further undeniable right. The framing of climate change as a set of rights raises a number of difficult issues in their implementation and in seeking to balance between competing fundamental rights (O'Brien et al., 2009). This argument applies to climate change in general including incremental change, and can be taken to apply 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 (see Section 3.2.2).

7.2.4. Subsidiarity

Subsidiarity, as specifically articulated in Article 5 of the Treaty of Maastricht on European Union (The Maastricht Treaty, 1992), 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 implies, 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 predominantly a national (and in many countries, e.g., Germany and India), primarily a 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 (AU) developed a continental wide African Regional Strategy for Disaster Risk Reduction (African Union, 2004). 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. With a similar intent on another continent, in 2010 Central American presidents approved the Central American Policy for Integral Disaster Risk Management [reference to be supplied].

7.2.5. Legal Obligations and Responsibilities

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

The intersections between climate change damage and international law have been assessed in detail by Verheyen (2005). 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 recognised 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, "recognised by civilized nations". This triumvirate of conventional and customary international law, and general principles of law, contain legal norms and obligations which 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", international norms exist in the form of non-legal resolutions, guidelines, and codes of conduct (Bodansky 2010; Chinkin 1989). Collectively these international legal and non-legal instruments provide a framework within which States have obligations and commitments of relevance to adapting to climate change and disaster risk management. These include obligations to mitigate the effects of desertification (United Nations Convention to Combat Desertification), to formulate and implement measures to facilitate adaptation (United Nations Framework Convention on Climate Change), to exercise precaution (Rio Declaration), and for international cooperation to protect and promote human rights (OHCHR , 2009 (para 84 *et seq.*)).

At the same time as international law appears to provide a normative framework and to impose obligations that mandate reducing and managing risk and helping adaptation to climate change, the literature also suggests that international legal instruments on their own are ill-equipped to live up to the challenge. To illustrate, the law of international disaster response, which establishes a legal framework for transborder disaster relief and recovery, has been characterised 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). International refugee law for its part does not recognise environmental factors as grounds for granting refugee status to those displaced across borders as a direct result of environmental factors (Kibreab 1997).

7.2.5.2. International Conventions

Few internationally negotiated treaties deal directly with managing risk at an international level associated with climate extremes or with adaptation to climate change.

The UNFCCC obligates 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 at 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." At .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." Linnerooth-Bayer and Mechler (2006) observe that support for insurance instruments as means of climate risk management is increasing. Article 4.8 of the UNFCCC requires

Parties to consider actions, including insurance, to meet the specific needs and concerns of developing countries. At article 3.14, UNFCCC's Kyoto Protocol considers the establishment of insurance mechanisms.

In addition to the UNFCCC, Parties to the UNCCD 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 (Fisher 2007).

7.2.5.3. Customary Law and General Principles

Customary law and general principles, unlike international conventions, emerge from informal processes and do not exist in canonical form (Bodansky 2010 (p. 192 *et seq*)), though customs and 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 considered part of customary law, a process is generally regarded as requiring two elements: continuous state practice (regular behaviour), and a sense of legal obligation (*opinio juris*) (Bodansky 1995-96). General principles of law, by contrast, are not customary norms and do not reflect behavioural 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), and general principles, is frequently blurred. For instance, the principle of common but differentiated responsibilities – 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 with respect to which states consider the principle to be a legal obligation. The principle of common but differentiated responsibilities might thus fall closer to a general principle than customary norm. Irrespective of this status, CBDR is nevertheless available to states in articulating their respective responsibilities under 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 treaties including article 3 of the UNFCCC. That states have a duty to prevent trans-boundary harm, provide notice of and undertake consultations with respect to such potential harms is another 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 Principle 18 of the Rio Declaration (a non-legal international instrument), that "States shall immediately inform other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment."

7.2.5.4. Non-Binding Legal 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. The Code of Conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organisations in Disaster Relief (1995) and the Sphere Project for Humanitarian Charter and Minimum Standards in Disaster Response (2004) focus on the quality of relief developed by the international humanitarian community, though are limited by lack of a compliance mechanism (Fidler, 2005). They are also limited in their application, since they are the creation of International NGO's and are rarely recognised in the policies of National Governments. The Guiding Principles on

Internal Displacement (UN Doc. No. E/CN.4/1998/52/Add.2 1998) articulates principles of indirectly related to 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 have generally a negative effect on the realisation of human rights including rights to life, adequate food, water, health, adequate housing and self determination (OHCHR 2009). These rights risk being jeopardised when contemplated, for example, in context of migration induced by extreme weather events. As discussed in Section. 7.3.1 the Hyogo Framework for Action further stipulates key tasks for governments and multi-stakeholder actors, among these are the development of legal frameworks. It 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 UNFCCC COP 13 recognises the need for disaster risk reduction strategies and risk management within adaptation (FCCC/CP/2007/6/Add.1).

7.3. Current International Governance and Institutions

Given the foregoing rationale for international action based upon considerations of systemic risk and international security, economc efficiency, solidarity and subsidiarity as well as legal obligations and responsibilities, what international governance institutions currently exist and how do they contribute to the management of disaster risks at the international level? The number and vatiety of institutions is very large. A full survey and assessment is well beyond the scope of this chapter, although it is a task that might be useful to undertake. The instituional assessments made in this report concentrate on the Hyogo Framework for Action (HFA) and the UN Framework Convention on Climate Change (UNFCCC) in Sections 7.3.1 and 7.3.2 respectively. Section 7.3.3 provides some minimal information on other current actors, knowing that this does not do justice to the many other institutions and capacities whose work relates to disaster risk management and climate change adaptation at the international level.

The international governance of disaster risk reduction and climate change adaptation is shaped and informed by several international policy frameworks. The significance of these loosely connected frameworks lies in their shared values, goals and approaches, formally agreed by the vast majority of national governments. Together, the policy frameworks form the working agenda for actions to reduce disaster risk and adapt to climate change.

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 *Hyogo Framework for Action* (HFA), to reduce disaster risk, and the *United Nations Framework Convention on Climate Change* (UNFCCC), which includes adaptation to the adverse effects of climate change. Since both disaster risk reduction (DRR) and climate change adaptation (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 *Millennium Development Goals* (MDGs).

The HFA and the UNFCCC were developed over different time frames by different UN agencies and without significant coordination. Since around 2005 however, governments have begun to encourage the international DRR and CCA communities to work together so as to avoid wasteful duplication, and to synchronise 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 (HFA)

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 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 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 (ISDR), which broadened the technical scope of the IDNDR to include increased social action, public commitment and linkages to sustainable development. The ISDR system promotes tools and methods to reduce disaster risk while encouraging collaboration between disaster reduction and climate change. The ISDR 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 risks. A key function is to facilitate the compilation, exchange, analysis and dissemination of good practices and lessons learned in disaster risk reduction (refer to 7.4.5 on knowledge creation, management and dissemination).

In January 2005, just three weeks after the Indian Ocean tsunami, the World Conference on Disaster Reduction (WCDR) was held in Kobe, Japan. 168 governments supported the *Hyogo Framework for Action (HFA) 2005–2015: Building the Resilience of Nations and Communities to Disasters*. The HFA was unanimously endorsed by the UN General Assembly (UN ISDR, 2005a). The HFA is not a binding agreement: the signatory governments simply agreed and adopted the framework as a set of recommendations to be utilised voluntarily. In international law it can be described as 'soft law'. However, since the HFA was adopted just after the tsunami it had greater international visibility and a sense of moral obligation.

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. Thus Pelling comments: 'not surprisingly given the vested interests of the dominant voices in the international community for the status quo, the framework is limited' (Pelling, 2011, p.44).

The main instruments to encourage HFA applications are the HFA Monitoring Service on Preventionweb acting mainly as a guidance tool and facilitating some peer pressure (refer to 7.4.5). Further tools include the reports to the sessions of the Global Platform for DRR and the regional platforms for DRR and other similar mechanisms. The HFA is also discussed in Chapter 1.3.6 and Chapter 6.3.2.1.

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 programmes (UN ISDR, 2005a). The Framework also provides five Priorities for Action PFA's

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

The priorities do not specify the need to factor climate change risks and adaptation into ongoing action, but 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).

7.3.1.2. Status of Implementation

As a result of the adoption of the HFA, and the development of performance indicators, global efforts to address DRR have become more systematic. In 2009, the first biennial Global Assessment Report on Disaster Risk Reduction (GAR) was released and on the same year the Global Network of Civil Society Organisations for Disaster Reduction also released a report on the performance of the HFA (GNCSODR 2009). The GAR report found that since the adoption of the HFA, progress towards decreasing disaster risk is varied across scales. This variation is based on national agencies self-assessment of progress against the indicators defined in the HFA and hence is not directly comparable across countries. Countries have been making improvements towards increasing capacity, developing institutional systems and legislation to combat DRR; and early warning systems have been implemented in many areas. However, progress is still required to mainstream DRR into planning and development since the GAR findings continued to state that current DRR governance arrangements do not allow for the full integration of risk reduction into development. Further, both GAR and the Global Network of Civil Society Organisation for Disaster Reduction (GNCSODR) noted that at national and international levels, policy and institutional frameworks for climate change adaptation and poverty reduction are faintly connected to those for DRR. Ecosystem management approaches can provide multiple benefits, including risk reduction and thus be a central part of such strategies. The GNCSODR observed that countries have difficulty addressing underlying risk drivers such as 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. Underlying risk factors – including poverty, ecosystem decline, poor governance systems and vulnerable livelihoods – are difficult but possible for countries to address using an assortment of mechanisms (e.g., micro-insurance) to increase resilience (UNISDR, 2009a).

It was also acknowledged in the report that weather-related disaster risk is escalating swiftly both in terms of the regions affected, frequency of events and losses reported. Furthermore, climate change is changing the geographical distribution, intensity and frequency of these weather-related hazards, threatening to weaken the resilience of poorer countries, their communities' abilities to absorb losses and recover from disaster impacts. Climate change is therefore a global driver of systemic risk (UN ISDR, 2009b).

The GNCSODR which evaluated the progress of HFA on each of its five Priorities for Action (PFA) found that the lowest level of progress across all the five PFA's was at the lowest scale i.e in community participation in decision making on DRR (GNCSODR 2009). These findings also indicate the need for a shift from 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. 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 7.4.5 on knowledge creation, management and dissemination). Civil society grass roots organisations report that climate change is providing the opportunity to address underlying risk factors, raise external resources and political commitment for building resilience. There is some recognition of the benefits in harmonising 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 could 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 (GNCSODR, 2009; UN ISDR, 2009a).

However, it is important to reflect on the reality that the three methods noted above to review international progress in risk reduction: country progress reports, the Global Assessment Reports of 2009 and 2011, and the reports of the Global Network of Civil Society Organisations do not constitute fully objective, scientific peer review assessments. The country progress reports and the GAR are both internally produced documents, thus having the status of grey literature These country HFA Reports are online at http://www.preventionweb.net/english/hyogo/progress/?pid:73&pih:2. The Global Network's publications are fully independent from the UN and Governments, but make no claim to be scientifically accurate assessments. However, in 2010 at the mid-point in the HFA, the UN Secretary General has reported that 'risk reduction is still not hardwired into the "business processes" of the development sectors, planning ministries and financial institutions' (UNGA, 2010 p.5).

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 ISDR published guidance notes on 'Indicators of Progress' (UN ISDR 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.

In preparing for the mid-term review of the HFA the UN ISDR secretariat commissioned a desk review of literature to form 'a baseline of the disaster risk reduction landscape' 47 key documents were identified, mainly consisting of reports from ISDR offices and partner organisations: NGO's, and International Development Banks (http://www.preventionweb.net/english/hyogo/hfa-mtr/?pid:73&pil:1).

However, none of these documents are peer reviewed academic studies. In preparing this report, despite an extensive search, the lead authors have not located any peer reviewed independent research into the effectiveness of the HFA programme from 2005–2011. Enquiries were made to senior staff in ISDR to identify any scientific peer reviewed assessments of the performance of the HFA. In response the authors of this report were advised that while they did not know of any peer reviewed academic papers, there was "a need to distinguish between lack of peer reviewed academic work and lack of progress". It was noted that a system had been put in place with indicators, self-assessment by Governments and analysis every two years in the Global Assessment Review as the Global Platform Sessions that brought a regional dimension to performance assessment. ISDR staff believed that these mechanisms effectively monitored progress and provided a wealth of information.

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 to face in the measurement of DRR and CCA before a disaster event must be recognised. 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 to 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). In early 2011 the full mid term review of progress with the HFA will be published.

["Notes to readers: During February 2011 after the completion of this Second Order Draft, the ISDR intends to publish a Mid-Term Review of HFA and this will be debated at the Third Global Platform in Geneva from May 8-13. We will endeavour to take this report into account in the final draft of this chapter to be written between May 20 and August 5, 2011.]

7.3.2. The United Nations Framework Convention on Climate Change

7.3.2.1. Evolution and Description

The United Nations Framework Convention on Climate Change (UNFCCC) is an intergovernmental treaty aimed at addressing climate change. Its ultimate objective as stated in Article 2 is "to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". (UN 1992) 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).

An important part of the UNFCCC and the subsequent negotiations about its implementation concern the mitigation of climate change: all policies and measures aimed at reducing the emission of greenhouse gases such as CO_2, or at retaining and capturing them in sinks such as forests, oceans and underground reservoirs. Adaptation to climate change was initially given little priority, although it is subject to various commitments in the UNFCCC (see Box 7-1) which when taken together acknowledge the systematic nature of climate change risks and the relevance of the principles of economic efficiency, solidarity and subsidiarity in adaptation.

_____ START BOX 7.1 HERE _____

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

Article 4.1b: Formulate, implement, publish and regularly update national and, where appropriate, regional programmes 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;

Article 4.1e: 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 4.1f: 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.

In addition, Article 4.8 states that '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.'

_____ END BOX 7-1 HERE _____

The *Kyoto Protocol*, agreed at COP3 in 1997 and in force since 2005, sets binding targets for 37 industrialised countries and the European Union for reducing greenhouse gas emissions by an average of 5% by the period 2008–2012. Adaptation is all but absent in the Kyoto Protocol, with one exception. Article 12.8, on the Clean Development Mechanism, provides the basis of what later became the Adaptation Fund.

7.3.2.2. Status of Implementation

There is no overall assessment of progress on adaptation under the UNFCCC in the way that the ISDR has made assessment of progress under the HFA in the Global Assessment Report (GAR) Parties to the UNFCCC are required however to make submissions (National Communications) on the implemetation of the Framework Convention incuding adaptation. There is however no common template for submissions on adaptation and these vary widely in content and frequency making an assessment problemmatic.The annual meetings of the COP allow countries to assess their progress towards meeting their commitments under the UNFCCC, and to negotiate and adopt new decisions for further implementation. By December 2010 there were 194 Parties to the UNFCCC: 193 countries and one regional economic integration organisation (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. 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 and Pilifisova, 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 on Adaptation (SPA) under the Trust Fund of the Global Environment Facility (GEF). In addition, COP7 took the first steps towards making operational the Adaptation Fund (see Section 7.4.2 for more information on the international financing of climate change adaptation).

Since 2001 a number of successive decisions have give 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 and is now undergoing review and extension. 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 socio-economic basis, taking into account current and future climate change and variability. The Nairobi Work Programme is implemented by Parties, intergovernmental and non-governmental organisations, 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 on 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 attached equal weight to mitigation and adaptation, and identified technology and finance as the key mechanisms for enabling developing countries to respond to climate change. It recognised the need for action to enhance adaptation in five main areas:

- International cooperation to support urgent implementation of adaptation actions, through vulnerability assessments, prioritisation of actions, financial needs assessments, capacity building, and integration of adaptation actions into sectoral and national planning
- Risk management and risk reduction strategies, including risk-sharing and transfer mechanisms such as insurance
- Disaster reduction strategies and means for addressing loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to climate change
- Economic diversification to build resilience
- Strengthening of the catalytic role of the UNFCCC in encouraging multilateral bodies, the public and private sectors, and civil society to build on synergies among activities and processes in order to support adaptation in a coherent and integrated manner.

In the event, 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 non-binding political declaration about which there was no consensus among parties, and which provides considerably less substance on adaptation than the Bali Action Plan (Klein, 2010).

Most recently, decision 1/CP.16 (part of the *Cancun Agreements*) established the Cancun Adaptation Framework. 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, subregional 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; (*iii*) a work programme 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 Centre 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 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 above 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 ten years, and some observers have argued that progress at the international level is too slow compared to the urgent need for action on the ground [reference to be supplied].

7.3.3. Current Actors

7.3.3.1. International Coordination in Linking DRM and CCA

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."(UN ISDR, 2009a).

The main coordination mechanism from the DRM side is the ISDR, designed to create a system of partnerships to support nations and communities to reduce disaster risk. These partners include governments, inter-governmental and non-governmental 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 programmes; reviewing national progress towards 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, including promotion of DRR programmes and integration into development planning, and capacity building (UN ISDR, 2005b). The UN ISDR Secretariat supports and assists the ISDR system. It is responsible for facilitating the coordination of actions at the international and regional levels; developing indicators of progress towards implementation of the Hyogo Framework; supporting national platforms and coordination mechanisms; stimulating the exchange of best practices and lessons learned; and, preparing reviews on progress (UN ISDR, 2009c). As a result, ISDR system appears to be in line with the principle of subsidiarity.

UNISDR has made specific efforts to link DRM and CCA, through advocacy of the role of DRR in climate change adaptation, and support for scientific reviews of the linkages (including this report). Independent evaluation of the UNISDR confirms its overall effectiveness, particularly in advocacy and awareness raising, and in establishing global and regional platforms, and specifically highlights its strong contribution to mainstreaming DRR into the climate change debate. However, it also highlights difficulties, including lack of definition of comparative advantage within CCA implementation, and the needs to balance the focus and resources spent on DRR in climate change versus the broader DRR concept. The same review also illustrates challenges in coordination for implementation, particularly the need for effective coordination with UN Country Teams, the World Bank and other relevant partners at country level, and in the full implementation and sustainable follow-up of new initiatives (Dalberg, 2010).

The main global coordination mechanism from the CCA side is The Nairobi Work Programme (NWP) of the UNFCCC (UNFCCC, 2010a) (Refer to 7.3.2.2 on implementation of UNFCCC). The NWP functions mainly as a forum for interested parties to specify their own contributions to CCA through "action pledges", and for sharing, synthesis and dissemination of information. DRR 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. Formal evaluation of the NWP is only now being carried out, so as yet there is no independent assessment of the degree to which it has supported changes in policy and practice as well as information exchange. The work of the NWP is clearly appreciated by UNFCCC Parties as the main stakeholders, and its mandate was extended in 2010 (UNFCCC, 2010b).

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 operation support.

7.3.3.2.1. Climate services for DRR and CCA

National Meteorological and Hydrological Services (NMHSs) are the primary source of observed and forecast on weather-related hazards, that is a critical component of planning for disaster risk management, as well as longer term projections to support climate change adaptation. These national services also constitute the members of the World Meteorological Organization (WMO), which serves to set international standards and coordinate among the members, as well as supporting several relevant international programmes, 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 weather climate information that is available from NMHSs at 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 (WHO, 2005)), or at local level (Vogel and O'Brien, 2006) conclude that the main deficit is not in generation of data, but in knowledge management, requiring greater attention to creating effective mechanisms for decision-makers and providers of weather and climate information to interact to manage climate risk.

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 Global Framework has four major components: a User Interaction Mechanism; World Climate Services System; Climate Research; and Observation and Monitoring. The initiative will focus on improving access and operational use of climate information in the most vulnerable countries, and will operate across international, regional and national levels. While the GFCS is not yet operational, and is therefore some way from being evaluated, the principles and focus of the initiative are well suited to linking DRM and CCA across international and other scales.

7.3.3.2.2. Technical and operational support from global civil society

Many international civil society organizations are now beginning to integrate climate change adaptation activities into long standing programmes on disaster risk management and humanitarian response.

One of the best-best established examples of civil society providing technical support to CCA and DRM integration is the Red Cross/Red Crescent Climate Centre in the Netherlands. This Centre seeks to understand and address the humanitarian consequences of climate change and extreme weather events. The Centre's main approach is to raise awareness; advocate for climate adaptation and disaster risk reduction (within and outside the Red Cross and Red Crescent); analyse relevant forecast information on all timescales and integrate knowledge of climate risks into Red Cross Red Crescent strategies, plans and activities.

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 (UN ISDR, 2010). A Global Network of Civil Society Organisations for Disaster Reduction was launched in 2007, and constitutes over 300 Organizations across 90 countries. It 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 (Mobilisation). One of the five core strategies of the Global Network is to develop synergies between DRR – Climate Change to address underlying risk factors (sustainable development), including adapting local level DRR monitoring infrastructure for climate adaptation, and input to the 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 (GEF)

The Global Environment Facility (GEF) is an independent financial organization established in 1991 and 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 financial mechanism for 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 Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF). Ten international agencies (UNDP, UNEP, World Bank, FAO, IADB, UNIDO, IFAD, and the World, African and Asian Development Banks, EBRD), implement GEF projects, usually in partnership with national or other international agencies.

7.3.3.3.2. World Bank Global Facility for Disaster Reduction 2006-2015

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a partnership of the ISDR system to support the implementation of the Hyogo Framework for Action (HFA). The GFDRR's mission is to mainstream disaster reduction and climate change adaptation in country development strategies. The Facility is made operational by the World Bank on behalf of the participating donor partners and other partnering stakeholders. It supports international collaboration, and provides technical and financial assistance to high risk low- and middle-income countries with the key objective for mainstreaming risk reduction into national development policies, plans and strategies to achieve MDGs.

Independent evaluation of the GFDRR illustrates the strengths and challenges of international collaboration in DRM and CCA. The facility has mobilized significant funds (over US$240 million in contributions and pledges from 2006-2009). It is also considered relevant and responsive to stakeholders, technically skilled, including within the context of climate change. Overall, it is considered to play a unique role in advancing scientific, economic and policy understanding of disaster risk reduction, and helping to bridge knowledge, policy, and practice in DRR services. However, important challenges remain in scaling up activities to the necessary level for a comprehensive response. At this early stage of development, the scale of the resources are remain considerably less than required, partnerships and policy integration at national level are uneven, and tools to ensure efficiency in monitoring and evaluation are not fully functional. Despite these challenges, the facility is considered to have achieved important progress on the ground, and to be implementing the necessary steps to improve function and to scale up implementation (Universalia_Management_Group, 2010).

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Box 7-2. DRM and CCA in the Context of International Development

Vulnerability to extreme weather and to gradual climate change is strongly conditioned by socio-economic development, including income levels and distribution, and 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, 2006). Countries that are relatively poor, isolated, and reliant on a narrow range of economic activities are particularly vulnerable to such shocks (UN ISDR, 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) the International Health Regulations (affecting the way that epidemics of climate-sensitive infectious diseases such as cholera are managed across borders), and codes of practice of international humanitarian organizations (such as the Red Cross Code of Conduct).

The most important framework for overall development is the Millennium Declaration, and the associated Millennium Development Goals (MDGs). These have been agreed by all members of the United Nations as well as 23 international organisations, with a target date of 2015. These are supported by international aid agreements, such as the Multilateral Debt Relief Initiative to cancel US$40-55 million dollars worth of debt, and the commitment of economically advanced countries to commit 0.7% of Gross National Income to Overseas Development Aid. The eight MDGs break down into 21 quantifiable targets that are measured by 60 indicators [Reference to be supplied].

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 towards the MDGs can help to increase resilience to extreme weather events, and to climate change. 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 was synchronized with the intended completion of the Millennium Development Goals (MDGs) by 2015.

While there are exceptions, the majority of the least developed countries, particularly in sub-Saharan Africa, are currently off-track to reach most of the MDGs. 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 Reference to be supplied].

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7.4. Options, Constraints, and Opportunities for DRM and CCA 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 recognising at the same time that international law is limited in scope and enforceability when applied to addressing these challenges.

7.4.1.1. Limits of International Law (Constraints)

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 must be substantiated by 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 twenty-five most disaster-prone states have signed up, limiting is relevance to many of the states that would most benefit from its provisions (Fisher 2007). International human rights instruments, which at face value are highly relevant to disaster risk response and in supporting an obligation to assist with adapting to climate change, do 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 universally adhesion (Lavoyer 2006), but is limited to situations of armed conflict. In contrast, the international disaster response law, 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 been described as "not yet equipped to respond adequately to the diverse causes of climate-induced migration" (Von Doussa et al 2007). 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 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 international law conventions, custom and principles which already announce the duty of states 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 candidate field for expanded interpretation is international refugee law. The extant definition of "refugee" is any person who, "for a well-founded fear of being persecuted" will not repatriate. The literature proposes the expansion of "persecution" to encompass being subject to environmental disaster or degradation (Warnock 2007; Kolmmanskog and Myrstad 2009). Comparably, article 7 the International Covenant on Civil and Political Rights prohibits torture and "cruel, inhuman, or degrading punishment". The literature notes the potential expansion of the meaning "degrading treatment" to include being left without basic levels of subsistence to the 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 emerging legal doctrine of "responsibility to protect" is also proposed in application to natural disasters. The emergence of state practices 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 context of natural disaster, and sources human rights law are to be used in promoting this doctrine (Saecho, 2006-2007).

7.4.2. Financing: Incentives, Disincentives, and Implications

Negotiations on financing for adaptation in the developing countries have remained prominent since adaptation was emphasized within UNFCCC process in Marrakesh during COP-7. The Bali Action Plan (BAP) has triggered actions that emphasised the need for international financing to support adaptation in the climate vulnerable developing and least developed countries (GEF 2008). All parties are actively engaged to ensure that the governance of international financing mechanisms becomes transparent, equitable in representation and possess clear lines of accountability (UNFCCC, 2007). Uncertainty still pervades the evolving governance process at the international level. The magnitude and timing of climate change impacts is uncertain and this uncertainty carries over into estimates of adaptation costs. However, it has become apparent that the scale of financing needed to meet the adaptation challenge is significant (GLCA, 2009; UNDP, 2007; OECD, 2008). Several international organisations have made calculations of the future cost of adaptation in developing countries, albeit based on rough assumptions and inconsistent timelines (shown in Table 7-1).

[INSERT TABLE 7-1 HERE:
Table 7-1: Estimated Annual adaptation costs in developing countries. Sources: Human Development Report, UNDP (2007); Economic Aspects of Adaptation to Climate Change: Costs, Benefits, and Policy Instruments, OECD (2008)]

Current International financing for adaptation is provided in a few dedicated funds through the Global Environment Facility (GEF) under the United Nations Framework Convention on Climate Change (UNFCCC) as well as through development assistance from bilateral and multilateral aid agencies. These funds are mostly designed to support the developing countries for raising awareness, building capacity, advancing understanding of risks and response options, and engaging developing country governments in prioritizing and assessing options (UNFCCC 2009a). Despite world leaders' rhetoric that financing is crucial for effective adaptation; the actual disbursements through these funds have so far been small in relation to estimated needs and only $0.9 billion has been disbursed against total pledge of nearly 18 billion by developed countries (Mitchell et al 2008).

The GEF manages the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF) and the Strategic Priority on Adaptation (SPA) (Refer to 7.3.2.2 on implementation of UNFCCC). Concerns are increasingly voiced at all levels about the effectiveness of current delivery mechanisms, and the control of funds. Procedural complexities, high transaction cost and unusual delays are reported as the major operational barriers for effective functioning of these funds (Klein and Persson, 2008). It has been argued that the GEF is yet to prioritize the adaptation needs of the most vulnerable and has disproportionately funded projects in countries that have relatively low rates of poverty (Mohner and Klein 2007). Developing countries characterise GEF governance as complex, time-consuming, bias to donor countries and lack of transparency (Mitchell et al. 2008). Instead of programmatic approach, the emphasis has been on supporting projects (Denmark Ministry of Foreign Affairs 2009; GEF 2005).

The decision for financing modalities at the international level was greatly influenced by the rich donor countries in the past (Burton et al, 2006) . Creation of innovative and new financing institutions was opposed by the OECD DAC Countries and, as an existing institution involved in environmental funding, GEF was identified as the preferred funding vehicle for adaptation (Klein and Persson 2008). It is commonly argued that donors resisted instituting a new regime of a kind that they feared would obligate new funds and may complicate the existing international aid system. Donors instead preferred to retain control of funding and urged the agencies to address gap issues through improved coordination (Suhrke and Ofstad, 2005). However in the current negotiations, many parties mostly from the developing world, have expressed their preferences for governance of adaptation funding within the ambit of the convention such as the Adaptation Fund and that funding should be adequate and predictable (Klein and Persson 2008).

The present humanitarian financing at the international level may, in some cases, discourage proactive risk management of climate extremes and catastrophic events. Greater predictability of emergency relief and humanitarian assistance at the international level as opposed to funds for DRM might help to create a false sense of security for many disaster vulnerable poor countries and due to this scarcity of resources, funding for adaptation to prepare for climate extremes and catastrophic events can be discouraged if countries can expect aid during crises (Hoff et al, 2005).

Assistance for adaptation at the international level could be governed in a manner that promotes 5 key principles of Paris Declaration for Aid Effectiveness endorsed by the ministers, heads of aid agencies and senior officials representing some 60 partner countries and more than 50 multilateral and bilateral development institutions. These include: (a) national ownership, (b) alignment with national priorities, (c) harmonisation through simplified and common procedures and shared analysis, (d) managing for results and finally and most importantly (e) mutual accountability.

Many cast climate change as a social justice issue (Michell et al, 2008) and international financing mechanism for adaptation could therefore channel resources effectively to those countries most in need. As many of the impacts will be at the local level, innovative strategies and techniques are needed to support local level initiatives and partnerships, including direct local level access to disaster risk reduction and climate adaptation trust funds and technical resources (GSCSODR, 2009).

To be effective, delivery mechanisms for climate change adaptation and disaster risk reduction are best when flexible and tailored to specific needs and contexts. Concerns have been raised by many donor countries that fiduciary risks in some countries must be managed through improved accountability and transparency before programme based adaptation to take place with international assistance (Michell et al 2009). Many developing and least developed countries require international assistance to build capacity and strengthen institutions for scaling up adaptation efforts (GEF 2008). Strong monitoring and evaluation structure are a crucial part of effective governance, of learning and of promoting efficiency and accountability in programme delivery mechanisms.

Concerns have been voiced whether the concurrent global financial crisis might reduce the priority for climate change adaptation and create another layer of barriers in resource mobilisation for adaptation at the international level. Experience has shown that hundreds of billions, even trillions, of dollars of public funds can be mobilized in a very short period in order to stimulate economic growth and protect against recession Reference to be supplied]. This has strengthened the argument that, if the world leaders are truly committed, there should not be much difficulty in mobilising international assistance to support climate change adaptation which requires in the order of tens of billions (GLCA, 2009). In the Copenhagen Accord (UNFCCC, 2009b), the sum of USD 30 billions of dollars for the period 2010-12 and USD 100 billions dollar annually by 2020 to address the needs of the developing countries and significant portion is like to channel through Copenhagen Green Climate Fund (UNFCCC 2009b).

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 natural 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 focus as opposed to a developer focus (O'Brien et al. 2007). 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. IEA (2001) lists the many kinds of obstacles (institutional, political, technological, economic, information, financial, cultural, legal and participation and consultation) to technology transfer and presents a series of case studies covering a broad range of technologies, economic sectors, geographical regions in mitigation and adaptation in which the transfer of technologies and practices were successful because concerted efforts were made to overcome these obstacles. Agrawala and Fankhauser (2008) review the economic aspects of adaptation. The report does not assess technology transfer but private-public partnership as a policy instrument could well be a mechanism for transferring the required technologies for adaptation projects. 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 the 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, non-governmental organizations (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.

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 awareness and preparedness. In the case of disasters related to extreme weather events, anticipatory adaptation is more effective and less costly than emergency measures; 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 (Christoplos et al. 2009).

A comprehensive 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 includes various types of geospatial information technologies such as mapping and surveying, videography, airborne laserscanning (lidar), satellite and airborne remote sensing, global positioning systems in addition to tide gauges, historical and geological methods and so forth. These technologies help formulate adaptation strategies (protection vs retreat), implement the selected strategy (design, construction and operation) and provide early warning. Another set of examples includes technologies to protect against sea-level rise: dikes, levees, floodwalls, seawalls, revetments, bulkheads, groynes, detached breakwaters, floodgates, tidal barriers, saltwater intrusion barriers among the hard structural options, periodic beach nourishment, dune restoration and creation, and wetland restoration and creation as examples of soft structural options. A combination of these technologies selected on the basis of local conditions constitutes the protection against extremes 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.

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, it is difficult to find even a single one that would be directly relevant for coping with weather extremes. 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 (see Box 7-3). Some other types of technologies are more recent, involving advanced materials science, perhaps, or satellite remote sensing. The UNFCCC report (2006b) provides an overview of the old and the new technologies available in adapting to changing environments, including climate change.

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

In Asia, Community based adaptation activities to climate change, variability and extreme events are small-scale and concentrate on agriculture, water and natural disaster amelioration (Alam et al. 2007). They typically have an emphasis on livelihood of the impacted community, diversification of agriculture, conservation of water and awareness raising to change practices. For example, Saudi Arabia has already implemented a number of projects to deal with climate related problems. These include construction of 215 dams for water storage, installation of 30 desalination plants, enactment of water protection and conservation regulation, leakage detection and control scheme, an advanced irrigation water conservation scheme and a system for modification of water pumping. Traditional as well as technological approaches are used to cope with the risk of drought in India. Technological management of drought uses medium (seasonal) to long-term (annual to decadal) forecasts that are formulated using models held appropriate by local experts. This information is then translated into early warning, and subsequently appropriate drought protection measures are taken. Another example is related to the Philippines. After Typhoon Sisang in 1987, which completely destroyed over 200,000 homes, the Department of Social Welfare and Development decided to instigate a programme of providing typhoon-resistant housing for those living in the most typhoon prone areas (Diacon, 1992). The Core Shelter houses are designed to withstand wind speeds of 180 km/h and have typhoon resistant features. The technology proved to be successful and was adopted recently in a region stricken by landslide (Government of the Philippines, 2008) and typhoons Government of the Philippines (2010).

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In the process of implementing technologies for adaptation to climate change, one of the critical components is the presence of appropriate and effective institutions (Klein et al. 2000, 2005). There exits a great deal of diversity among these institutions and they differ significantly in terms of operating scales, such as small to medium to large and spatial scales such as local to national to international. Differences also exist in terms of their sectoral involvement such as agriculture, water, forestry, transport etc. and in their status as formal (*e.g.*, Ministry or Department of Environment, NAPA Secretariat) or informal (*e.g.*, a local village community). Formal institutions can respond to adaptation needs and challenges with policies, plans, guidelines resource allocation etc while informal institutions often respond to specific adaptation challenges such as drought, flood or a cyclone as self-organised and self-motivated systems. There exits a range of institutions in between these two extremes with different degrees of formalisation. For example, NGOs can play important roles in advancing adaptation technologies. Local institutions in adaptation that play a role in adaptation are also important for technology transfer (Agrawal et al. (2008).

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 a broad range of technologies that have wide-ranging potential applications at various stages of disaster management. Technologies for the following applications are particularly important for adaptation to weather-related extreme events as well:

- Early warning and disaster preparedness
- Search and rescue of disaster survivors
- Energy and power supply
- Food supply, storage, and safety
- Water supply, purification, and treatment
- Medicine and healthcare for disaster victims
- Sanitation and waste management in disaster mitigation
- Disaster-resistant housing and construction.

Developing wind-resistant building technologies is crucial in reducing vulnerability to high-wind conditions like storms, hurricanes and tornadoes. A report by the International Hurricane Research Centre (IHRC) presents Hurricane Loss Reduction Devices and Techniques (IHRC, 2006). The Wall of Wind testing apparatus (multi-fan systems that generate up to 130 mph 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.

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, to the extent it is possible, early warning systems must provide multi-hazard warning to be really useful. Satellite and aerial monitoring, meteorological models and computer tools including 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 becomes increasingly important in the USA. The National Association of State Chief Information Officers (NASCIO, 2006) presents the benefits of using geographic information systems (GIS) technologies to inform the public, enable officials to make smarter decisions, and facilitate first-responders efforts to effectively locate and rescue storm victims. Lack of locally useable climate change information remains an important constraint in managing weather-related disasters. Therefore there is a need to develop regional mechanisms to support in developing and delivering downscaling techniques and tools (see Chapter 3, Section 3.2.3 for details on downscaling regional climate models).

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 events such as drought, flood and storms (Rukieh and Koudmani, 2006). The use of such technologies can be particularly useful in the risk assessment, mitigation and preparedness phases of disaster management. Space technologies are also vital to the early warning and management of the effects of disasters. In order for the developing countries to be able to incorporate the routine use of space technology-based solutions there is a need to increase awareness, build national capacity and also develop solutions that are customized and appropriate to the needs of the developing world. A good example of application of space technology at international scales and early warning is the WMO-National Oceanic and Atmospheric Administration-USAID-Hydrologic Research Center initiative on global flash flood guidance. The system uses global data produced by a global center, downscales the global information to regional products which are sent to national entities for further downscaling at national level and then disseminated to users and communities (WMO, 2007, 2010). It should also be noted 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 relief agencies and governments depend, among other factors, on timely availability of information (Holdaway, 2001). This support depends on the timely availability of information about the scale and nature of these disasters. Currently ground-based sources provide most of such information. There is an increasing recognition that significant input could be provided by space-based sensor systems, both for disaster warning and disaster monitoring. Recent major disasters have demonstrated that the scale of devastation cannot adequately be monitored from ground-based information sources alone. The author presents a global space-based monitoring and information system, with the associated ability to provide advanced warning of many types of disaster, together with the latest developments in sensor technology (optical, IR, Radar) including a UK initiative in high resolution imaging from a microsatellite. Transferring these technologies and the related know-how is important for building capacities in CCA and DRM in countries where they are still missing.

Microsatellites (unusually low weights and small sizes, just under or well below 500 kg) are seen as an important technology for the detection and preparation for weather related disasters 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 are currently cooperating with the United States, Europe and other nations to develop small earth observation satellites.

Promising satellites include DAICHI (Advanced Land Observing Satellite) and WINDS (Wideband Internetworking engineering test and demonstration satellite) that include both optical and microwave sensors). DAICHI was launched in 2006 and is based on cooperation of Asian countries with the USA and EU (Holdaway 2001).

Based on the session "Disaster Mitigation, Warning Systems and Societal Impact" at the Sixth International Workshop on Tropical Cyclones, Lee et al. (2006) focus on the application aspects of tropical cyclone forecasting and warnings, and the way such information is conveyed to stakeholders, users and the general public for the mitigation of adverse cyclone impacts. This aspect of an effective warning system incorporates two components: reliable forecasting of tropical cyclones and efficient conveyance of warning information. Among others such measures as satellites, EPS (Ensemble Prediction System) are increasingly becoming important. NMHSs (National Meteorological and Hydrological Services) should take advantage of the advances in communication technology such as wireless broadband access, GPS and GIS to enhance the relevance and effectiveness of warnings, options and backup capabilities to disseminate warnings through multiple and diverse channels with a variety of high and low technology. In addition to specific technology components, early warning systems (EWSs) should promote an integrated approach to link technology to population at risk. The weakest part of most of the early warning system is lack of linkages of systems components. Therefore EWS components ranging from collection of hydro-meteorological data, forecasting on how the nature will response (e.g. weather or flood forecasting) to communicating information (or warnings) to decision makers (sectoral users or communities) timely, and disseminating information to population at risk and community actions should be linked closely.

Natural hazards research has advanced to address a major challenge that is turning real-time data from new technologies (e.g. satellite and ground-based sensors and instruments) into information products that people can use to make better decisions about their safety and prosperity (Groat 2004). The issue of tracking floods may be taken as an example of that. This indicates the importance in natural hazards research of turning real-time data from new technologies (e.g. satellite and ground-based sensors and instruments) into information products that people can use to make better decisions about their safety and prosperity.

The literature about technology transfer to foster adaptation to changes in extreme events induced by climate change is very limited. However, by broadening the scope to climate change adaptation in general, lessons about the processes, channels, stakeholders and barriers can be gained. In addition, useful insights might be inferred from the literature on technology transfer to support climate change mitigation, natural disaster preparedness and management, and other related areas.

7.4.3.3. Financing Technology Transfer

So far most of the attention regarding innovative financing has been devoted to the mitigation side of the climate change challenge. Several financing mechanisms have emerged that aim to catalyze important change agents, facilitate trading of credits (i.e., carbon or renewable energy), and provide greater overall flexibility for the private sector to invest in environmentally sustainable technologies. Nothing comparable has thus far emerged for the adaptation side where potential technology transfer investments are still associated with insufficient incentive regimes, increased risks and high transaction costs.

In the cases of many industrial or energy technologies the results of penetration in the developing countries depended on many factors including skill base at the recipient countries, appropriate market conditions, technology levels and assured supply of services such as electricity and water, appreciation and implementation of quality control, availability of spare parts etc. Often it is a variety of interconnected issues - socio-economic, institutional and governance – that have determined the degree of success of technology transfer, rather than the technologies themselves (Klein, 2005, p. 23). These factors are also important in transferring technologies for adaptation.

UNFCCC (2005) addresses the development and transfer of environmentally sound technologies for adaptation to climate change: such as the needs for, 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 Special Climate Change Fund (SCCF), the LDC Fund, financial flows generated by Joint Implementation and clean development mechanism projects, and the private sector (Refer also to 7.3.3.3 on International Finance Institutions and Donors). The GEF funds for adaptation activities include the Strategic Priority on Adaptation (SPA) trust fund, the LDC Fund and the SCCF. In addition, the GEF is providing secretariat services to the Adaptation Fund Board under the Kyoto Protocol (see also 7.4.2 on Financing). A sensitive issue in technology transfer is when it involves technologies protected by intellectual property rights and must be implemented in accordance with international law.

Climate variability is already a major impediment to development and 2% of the 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 2010, 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, LDC Fund, 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 (TNAs) could be implemented using these financial opportunities. Based on these experiences as well as on special needs of groups of countries such as SIDS 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 Convention and estimates the financing resources currently available for technology research, development, deployment, diffusion and transfer. The estimates for mitigation technologies are between USD 70 and 165 billion per year. In the adaptation area, the report claims that R&D 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 USD 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 whether-related extreme events appear to be an important for both CCA and DRM.

7.4.4. Risk Sharing and Transfer

This section examines the current and potential role of the international community – international financial institutions (IFIs), 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 chapter 6.3.3.3.) 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, and this 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 through formal means) and risk sharing (usually informal with no payment) is recognized by the international community as an integral part of DRM and CCA. The 2005 Hyogo Framework for Action calls on the disaster community "to promote the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters" (UN ISDR, 2005a: 11). Similarly, the 2007 Bali Action Plan calls for 'consideration of risk sharing and transfer mechanisms, such as insurance' as a means to address loss and damage in developing countries particularly vulnerable to climate change (Decision 1/CP.13, Bali Action Plan). The Plan strengthens the mandate to consider insurance instruments, as set out by Article 4.8 of the UN Framework Convention on Climate Change (UNFCCC) and Article 3.14 of the Kyoto Protocol. In response, two proposals for including insurance in an adaptation regime have recently been put forward (MCII, 2008; AOSIS, 2008).

Often by necessity risk sharing and transfer is international (see sections 5.5.2.2 for definitions). Local and national pooling arrangements (discussed in Chapters 5 and 6) 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 arrangement for sharing and transfer risk:

- 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 their risks and better enables them to purchase reinsurance.

Not only are these financial arrangements international in character, but they are increasingly supported by the international development and climate adaptation communities (see, especially, UN ISDR, 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 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 ex-pat communities to their home countries, make up a large part of informal risk sharing and transfer, even exceeding official development assistance. In 2006, the official worldwide flow of remittances was estimated at more than $250 million, and unrecorded flows may add another 50% or more. In some cases, remittances can be as large as a third of the recipient country's GDP (World Bank, 2006).

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; Mahapatra 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 UK 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 financing of terrorism (Fagen and Bump, 2007). Finally, a major problem is difficulties in communicating with relatives abroad, as well as the high potential to lose 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. (Pickens et al., 2009; DFID, 2005)

7.4.4.2.2. Post-disaster credit

As 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 USD 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 (CAT DDO), which disburses quickly after the borrowing 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 Inter-American Development Bank (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

As an instrument for distributing disaster losses among a pool of at-risk households, businesses and/or governments, insurance 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 per cent of the total in 2007 (Mills, 2007). With insurance and reinsurance markets attracting capital from international investors, insurance has become an instrument for transferring disaster risks over the globe. The market is highly international in character. In the period 2000-2005, for example, U.S. insurers purchased reinsurance annually from more than 2,000 different non-U.S re-insurers (Cummins and Mahul, 2009: 115) Yet, the market is unevenly distributed. From 1980 through 2003 insurance covered four per cent of total losses from climate-related disasters (estimated at about USD 1 trillion) in developing countries compared to 40 per cent 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-isurance program, which provides index-based drought insurance to smallholder farmers (Suarez, et al., 2007; Hess and Syroka, 2005)
- The Mongolian government and World Bank support the Mongolian Index-Based Livestock Insurance Program by absorbing the losses from very infrequent extreme events (over 30 per cent animal mortality)

and providing a contingent debt arrangement to back this commitment, respectively (Skees, et al., 2008; Skees and Enkh-Amgalan, 2002)

- The World Food Programme (WFP) 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, 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 below) (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, 2009; Miamidian, 2005).

Insurance and other risk financing instruments are particularly effective for adaptation, when used in conjunction with or when creating incentives for risk-reduction activities. Supporters point out that insurance contracts with premiums based on risk will reward preventive behaviour, and Kunreuther and Michel-Kerjan (2009) show how this incentive could be more effective if insurers offered long-term contracts. Insurance can also be directly linked to risk reduction. As one innovation, a micro-insurance scheme in Ethiopia is providing reduced premiums to farmers who provide their labour in the off season for risk-reducing projects (Suarez et al., 2009).

7.4.4.2.4. Alternative insurance instruments

Alternative insurance-like instruments, sometimes referred to as risk-linked securities, are innovative financing devices that enable risk to be sold in international capital markets. Given the enormity of these markets, there is large potential for alternative or non-traditional risk financing, including catastrophic risk (CAT) bonds, industry loss warranties (ILWs), sidecars, 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 we draw 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 hurricane category 4 or greater), but shares the insurer's or government's losses by sacrificing interest or principal following the event. Over 90% of cat bonds are issued by insurers and reinsurers in developed countries. Although it is still an experimental market, CAT bond issues more than doubled between 2005 and 2006, with a peak at $4.7 billion in 2006 (Cummins and Mahul, 2009).

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 the government of 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 and counterparty credit risk are further impediments 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. In 2006 the World Food Programme (WFP) 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 (Wiseman and Hess, 2007). While this transaction relied on traditional re-insurance 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 a backup for humanitarian aid when disasters strike.

7.4.4.2.5. International 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 pooling risks across individual countries or regions, catastrophe insurance pools generate diversification benefits that reduce insurance premiums. By accumulating reserves over time, pools are able to increase risk retention and eventually insurance premiums., Finally, there is growing empirical evidence that catastrophe insurance pools have been able to diversify inter-temporally 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, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) was established in 2007 to provide Caribbean Community (CARICOM) 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, 2007b). The governments of Bermuda, Canada, France, the United Kingdom, as well as the Caribbean Development Bank and the World Bank recently pledged a total of US $47 million to the CCRIF reserve fund.

7.4.4.3. Value Added by International Interventions

International Financing Institutions (IFIs), 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 for 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 (Pickens et al., 2009; DFID, 2005);
- *Financing risk transfer*, as examples, the Bill Gates Foundation subsidizes micro-insurance in Ethiopia (Suarez et al., 2009); the World Bank provides low-cost capital backing for the Mongolian micro-insurance program (Skees, et al., 2008); Swiss SECO and IDB provide low-interest credit to the ELF (UNFCCC, 2008), and many countries have contributed to the CCRIF fund (Cummins and Mahul, 2009).

These are only a few examples of increasing 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. 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). Critics point to the "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. Other types of support, 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. (see, e.g., Skees, 2001; Gurenko, 2004)

Recognizing these concerns, there are important and valid reasons for interfering in catastrophe insurance and other risk-financing markets in specified 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 improved 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, eg., to limitations on private capital and the uncertainty and ambiguity about the frequency and severity of future losses (Kunreuther, 1998). In this case economically justified premiums that are lower than those charged by the imperfect private market may be appropriate (Cutler and Zeckhauser, 1999; Froot, 1999).
- The target population cannot afford sufficient insurance cover, 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 Creation, Management, and Dissemination

A close integration of DRR and CCA and their mainstreaming into developmental 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; information on access to appropriate technologies and risk sharing and transfer mechanism for disaster risk reduction (see sections 7.4.1-7.4.4 above) are key to integrated risk management. Collaboration among scientists of different disciplines, practitioners, policymakers and the public is pertinent in knowledge creation, management and accessibility (Thomalla et al., 2006). The type, level of detail and ways of generation and dissemination of knowledge will also vary across scale i.e. from the local level where participatory approaches are used to incorporate indigenous knowledge and build collective ownership of knowledge generated; to the broader regional to international levels thus upholding the principle of subsidiarity in the organisation, 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, sometimes this is carried out by institutions with no clear international mandate and the quality of the data and its coverage are inadequate. In other cases 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 datasets. The major challenge in achieving coordinated integrated risk management across scales is in establishing clear mechanisms for a networked programme 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 organisations such as the World Bank, DFID and Inter-American Development Bank (IDB); bilateral organisation such as Canadian International Development Agency (CIDA), European Commission (EC) and so forth (Benson et al., 2007). Accounting for climate risks within the development context will among others be effectively achieved where appropriate information and knowledge of what is required exit and is known and shared (Ogallo, 2010).

7.4.5.1. Knowledge Creation

Knowledge creation by its nature is a complex, continuous and non-linear and life-long process. Knowledge creation 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 in emphasis by HFA from reactive emergency relief to pro-active DRR to strengthen prevention, mitigation and preparedness and link with changes in CCA for instance from the traditional global view of climate change to the need for adaptation to focus on local scales (refer to 7.4.3.2 on Technologies for Extreme Events). This shift is rapidly extending to the public as shown by evidence that under a two year period, up to December 2010, a total of 480,984 chapters of the ISDR Global Assessment of Disaster Reduction Report had been downloaded (this is an aggregate figure for all chapters in all languages). The Global Spatial Data Infrastructure (GSDI) which aims to coordinate and support the development of Spatial Data Infrastructures world-wide provides important services for a pro-active DRR approach (Köhler and Wächter, 2006).

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 (GEC) information that extends into DRR and CCA. ICSU a non-governmental organization with a global membership of national scientific bodies (121 members) and international scientific unions (30 members) that however maintain a strong focus on natural sciences (http://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 programmes facilitated by ICSU: DIVERSITAS, International Geosphere Biosphere Programme (IGBP), International Human Dimensions Programme (IHDP) closely tied to ISSC and the World Climate Research Programme (WCRP). These programmes have been supported by a capacity building and information dissemination wing; the System for Analysis, Research and Training (START). The four GEC programmes have had a significant role in generating the background science that forms the basis for CCA and DRR (Steffen et al., 2004). For CCA the link between science and policy is achieved through the IPCC process while for DRR it is through activities of ISDR.

However, there has been growing concern that GEC programmes are not integrated and provide fragmented information limited to certain disciplines. This concern led to the establishment of Earth System Science Partnership (ESSP) aiming to integrate natural and social sciences from regional to the global scale but it has failed to answer 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 future (ISCU, 2010; Reid et al, 2010). An assessment of climate services for DRR and CCA is given in secion7.3.3.2 above. But the generation of climate change information has followed a top down approach relying on global models to produce broad scale information usually with large uncertainties and complex for the public to assimilate hence providing no incentive for policy makers to act on the risks that are indicated (Schipper and Pelling, 2006; Weingart et al., 2000). Climate change information by its definition has to be provided at long temporal ranges, e.g. 2050, which is far beyond the 5 year attention span of political governments let alone that of the poor people concerned with basic needs. The ongoing effort to enhance delivery of information at inter-annual to inter-decadal scale will improve assimilation of climate information in risk management (Vera et al., 2010). Further, 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 in developing countries where education levels are low and communication networks are poor (Vogel and O'Brien, 2006) . In general locally relevant climate change risk information to effectively address CCA is lacking and the capacity to generate such information is inadequate a factor contributing to vulnerability (Weingart et al., 2000; Schipper and Pelling, 2006).

Knowledge acquisition and documentation requires capacity in terms of skilled manpower, infrastructure and appropriate institutions and funding (refer to 7.4.3.1 on Technology and Climate Change Adaptation). Long-term research and monitoring with a wide global coverage of different hazards and vulnerabilities is required (Kinzig, 2001). For e.g. forecasting a hazards is a key aspect of disaster prevention but generating such information comes with a cost. Although weather forecasting through meteorological networks of WMO is fast improving, the network of meteorological stations is far from being adequate spatially and some have ceased to operate 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 policy and the public (Vogel and O'Brien, 2006; Carvalho, 2007).

Interdisciplinary generation of information i.e. bridging the traditional divide among the social, natural, behavioural, and engineering sciences continues to be a great intellectual challenge in climate change risk reduction. For e.g. despite the value of IT in DRR and CCA information retrieved through the Internet is rarely cross disciplines (Marincioni, 2007). The newly formed ISDR sponsored and ICSU promoted Integrated Research on Disaster Risk programme(IRDR) which aims at applying an integrated approach in understanding natural and human-induced environmental hazards will contribute towards building a comprehensive international knowledge bank on DRR and CCA (McBean, 2010).

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 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 are being made to improve the situation (Ogallo, 2010). 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 chapter 5 and 6). However, evidence of rapidly expanding public interest in DRR is that in under a two year period, up to , December 2010, a total of 480,984 chapters of the ISDR Global Assessment of Disaster Reduction Report had been downloaded - this is an aggregate figure for all chapters in all languages.

Disaster response and recovery are closely linked to provision of effective communication prior to and throughout the disaster situation (Paul, 2001; Zhang et al., 2002). Mass media e.g. Radio, Television sets 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 have been found to provide a more effective approach to information dissemination (Maibach et al., 2008; Chagutah, 2009; Kaklauskas et al., 2009).

Increased use of information communication technology (ICT) such as mobile phones, online blogging websites with interactive functions and links to other web pages and real time crowd-souring electronic commentary and other forms of web based social networked communications such as Twitter, Facebook etc. represent current tools for timely delivery of disaster information to people who need it, where such information is given in an appropriate format and language and facilitates to deliver the available information (Glik, 2007). There are emerging attempts to develop mobile phone based disaster response services for e.g. 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 industrialised countries and the process is rapidly expanding to developing countries.

Information sharing and dissemination for disaster relief has improved through the established of ReliefWeb site (http://www.reliefweb.int) by UN OCHA in 1996. The ReliefWeb site so far offer the largest internet based international disaster information gathering, sharing and dissemination (Wolz and Park, 2006; Maitland and Tapia 2007; Saab et al., 2008). The International Charter (http://www.disasterscharter.org) provides space data that serves to augments the RelifWeb. But the UN OCHA ReleifWeb does not cover preparedness and disaster prevention to fully embrace CCA and DRR.

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 is yet to be exploited. The UN OCHA ReleifWeb poorly represents local to national level humanitarian activities for e.g. most of this information is not translated into different languages (Wolz and Park, 2006). There are still large sections of the global population who have no access to Internet and other telecommunication service (Samarajiva, 2005) although evidence shows that improved access by disaster workers has overall positive effects on disaster relief (Paul, 2001; 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 an innovative measures being put in place to address the problem of limited access to internet in developing countries (Boulahya et al., 2005). Sustainable use of ICT for coordination of information for humanitarian efforts face challenges of limited resources to mount, maintain and upgrade these systems because donors demand that overhead expenses, including IT, should be kept to a minimum (Saab et al., 2008). ICT is also limited to explicit knowledge that is comprised of, e.g., 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

A great deal of knowledge dissemination is accomplished in academic institutions but this does not translate automatically to the general public. The use of information technologies (IT) such as computer networks, digital libraries, satellite communications, remote sensing, grid technology, Geographic Information Systems (GIS), for data and information integration for knowledge creation and exchange for growing to be important in integrating DRR and CCA (UN ISDR, 2005b; Louhisuo et al., 2007; see also 7.4.3.2 on Technologies for Extreme Events). IT offers interactive modes of learning which could be of value in distance education and online data sharing and retrieval. For e.g. the Center for Research on the Epidemiology of Disaster (CRED) Belgium (http://www.cred.be/) maintains the Emergency Events Database (EM-DAT) which has over 18,000 data on disasters in the world from 1900 to present. This data is useful for disaster preparedness, and vulnerability assessments (CRED, 2006). Another example is the DesInventar database in Latin America, developed in 1994 by the Network for Social Studies in Disaster Prevention (LA RED) is an inventory of small, medium and greater impact disasters (http://www.desinventar.net/) and aims to facilitates dialogue for risk management between actors, institutions, sectors, provincial and national governments. This initiative has been extended to the Caribbean, Asia and Africa by UNDP while UNFCCC provides a more local scale database on local coping strategies http://maindb.unfccc.int/public/adaptation> (UNFCCC, 2007).

IT capabilities in disaster risk reduction also lies in enhancing interaction among individuals and institutions from national, regional to international level e.g. through e-mail, newsgroups, on-line chats, mailing lists and web forums (Marincioni, 2007). Attempts have been made for example, in Japan to create an integrated disaster risk reduction systems where mobile phone communication operates as part of a greater information generating and delivery chain that includes earth observation data analysis, navigation and web technologies, GIS and grid (Louhisuo et al., 2007). But this has not been transferred to other regions.

Other initiatives include the NetHope International that combines development and disaster issues into its IT-centric mandate (Saab et al. 2008). While RANET (http://www.oar.noaa.gov/spotlite/archive/spot_ranet.html) originally developed in Africa for drought and spread to Asia, Pacific, Central America and 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 spin offs 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 RAINET to translate information into local context and languages and as a result RAINET is being considered for other educational initiatives such as the Spare Time University to improve access to learning in DRR with benefit on CCA (Glantz, 2007). RAINET has been found to reduce vulnerability to climate extremes in different areas in Africa but the main challenge is availability of technical support, follow-up training, power supply, and coordination (Boulahya et al., 2005).

From the Un ISDR, the emergence of the PreventionWeb (www.preventionweb.net/) facility, specifically to support of the HFA, signal the huge potential of IT in information sharing for international disaster risk management across scales. PreventionWeb has been evolving since 2006 and was built on the experience of Relief Web with the purpose of becoming a single entry point to the full range of global disaster risk reduction information and hence provides a common platform for institutions to connect, exchange experiences and share information on DRR, facilitating integration with CCA and the development process. Updated daily, the PreventionWeb platform contain news, DRR initiatives, event calendars, online discussions, contact directories, policy and reference documents, training events, terminology, country profiles, factsheets as well as audio and video content. Hence while catering primarily for professionals in disaster risk reduction 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 but its full potential is yet to be realised and evaluated since it is still evolving.

In addition to the PreventionWeb with a DRR focus the number of web-based resource portals supporting both DRR and CCA have been increasing. These include among others, ProVention Consortium which had a DRR and climate focus (www.proventionconsortium.org/) but has now ceased to operate; Adaptation Learning Mechanism (www.adaptationlearning.net); Linking Climate Adaptation Network/CBA-X which has some DRR focus too (www.linkingclimateadaptation.org) and WeAdapt/WikiAdapt, an adaptation focus portal (www.weadapt.org). As a result most of these remain effectively used by their respective communities and have been noted to be poorly organised (Mitchell and Aalst, 2008). Performance of such IT information resources in disaster risk management could improve with more coordination and integration of CCA, DRR and development community.

7.4.5.2.2. Constraints in knowledge sharing and dissemination

Further all information tools noted, the quality of information transferred and language used influence their effectiveness and often these mechanisms 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 even the most innovative tools like RANET show numerousmaintenance constraints particularly in remote areas (Boulahya et al., 2005).

There are differences in perception on the role of IT in the exchange of disaster knowledge as opposed to its role in increased flow of information, with knowledge here defined simple 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 which is partly attributed to lack of effective sharing (Zhang et al., 2002; UN ISDR, 2005b).The level of assimilation of IT technology in disaster risk reduction depends among others on levels of literacy and working environment including institutional arrangements hence effectiveness may vary with levels of development (Marincioni, 2007; Samarajiva, 2005; see also 7.4.3.2 on Technologies for Extreme Events). As a result the contribution of these relatively new facilities such as PreventionWeb will among others depend on accessibility and assimilation of IT in daily operations of institutions across the globe. Evidence show 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 constrain in climate change risk management results from the fact that communities working in disaster management, climate change and development operate separately even though they are all concerned with human wellbeing and this increases vulnerability to climate extremes leading to disasters (Schipper and Pelling, 2006; Lemos et al, 2007). For e.g. emphasis on humanitarian assistance has been attributed to faulty development leading to increased vulnerability (Benson and Twigg, 2007), while development community members are for example likely to be better equipped on the use of insurance they fail to link this to climate risk reduction exposing communities to vulnerability to climate extremes. Similar observations have been made on cities where urban developers have no link with 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 results from different language styles and jargons. Heltberg et al, (2008) have suggested a need for establishing universally shared basic operational definition 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 e.g. for better coordination among numerous humanitarian organizations (Saab etal., 2008) and in the FAO guide for disaster risk management (Baas et al., 2008; Also see Chapter 1). The move towards establishment of National Disaster Risk Reduction institutions that link to similar regional and international structures by for example UN ISDR provides a framework for bringing different stakeholders together including climate change and development community 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 literature shows that data and information on their own are 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. The international community needs to identify what information is essential for different stages of climate change risk management, 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 development community are still being weakly formulated yet these hold the promise to reducing vulnerability to disasters in future.

7.5. Consideration for Future Policy and Research

How best can the experience with disaster risk reduction at the international level be used to help or strengthen climate change adaptation? The characteristics of the DRR regime (chiefly ISDR 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 limited assessment literature allows. One clear conclusion 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"(Birkman and von Teichman 2010).

The call for integration of disaster risk reduction with climate change adaptation goes much further however (UN ISDR 2009a). It is argued that both disaster risk reduction and climate change adaptation remain outside the mainstream of development activities. The United Nations Global Assessment Report on Disaster Risk Reduction (GAR) 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 (pp176-177).

These policy proposals come from an official UN report (UN ISDR 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, German Committee for Disaster Reduction 2009, Commission on Climate change and Development 2009) as well as in the advocacy literature (Tearfund 2008).). More recently the widely reviewed ICSU (2010) report (called the Belmont Challenge) on Regional Environmental Change: Human Action and Adaptation that was commissioned by the major global environmental change research funders to assess 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 programme to deliver integrated knowledge required to identify and respond to hazards, risks and vulnerability, and develop mitigation and adaptation strategies. Similarly ICSU and the International Social Science Council (ISSC) carried out a wide consultative process to rethink the focus and framework of Earth system research. This consultation came out with four The Grand Challenges which 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 behavioural changes to enable effective steps toward global sustainability.

Both the Belmont Challenge and the Grand Challenges are setting a 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 slowed to develop. One constraint is the difficulty of integration across scales, which is addressed in section 7.6 below. Two other sets of constraints are described as “the normative dimension” and “the knowledge dimension” (German Committee for Disaster Reduction 2009). The following challenges and constraints have been identified:

- Normative Dimensions (adapted from German Committee for Disaster Reduction 2009)
  – Absence of uniform methods, standards and procedures in vulnerability and capacity assessment and also in the design, formulation and implementation of adaptation plans, programmes 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 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.
  – The perception of climate risks as being a threat caused by external agents limits the level of acceptance of responsibility and awareness to act on adaptation.
  – Final objectives of education are the acquisition of knowledge as well as socialization. Thus capabilities are developed on a common denominator and the diversity of thinking is reduced, thus leaving little room for the creativity that is necessary for finding solutions to global problems such as DRR and CCA. Education systems in most countries focus on basic knowledge acquisition and socialization often limited to specific disciplinary focus, with little time or resources allocated towards creative problem solving. Such creative problem solving, and integrated thinking, is essential to addressing the complex socio-economic challenges of climate change (ICSU, 2010 and Reid et. al. 2010).
  – People’s exposure to hazardous areas in many countries is often caused by lack of enforcement of existing laws, standards or inappropriate land-use plans and the pursuit for quick economic returns. The revisions of existing standards and plans are constrained by the lack of awareness and norms for adaptation and attraction to temporal economic benefits at the expense of long-term consequences. In many countries zoning standards and laws, or lack of enforcement, lets people live and settle in hazardous areas provoking not only human suffering but also immense costs for the insurance companies – lack of norms for appropriate adaptation hinders the revision of existing standards.
  – The lack of standards and methods on general standards and norms of how to link DRR and CCA are often seen as potential barriers that for hinder the effective cooperation and development of indicators that could help towards improvement of vulnerability and capacity assessment as well as the methods for evaluation of adaptation policies, strategies and plans. and their success.
- Knowledge Challenges (adapted from German Committee for Disaster Reduction 2009)
  – Differences in the form of terminology used i.e. the different terms and definitions framed by both DRR and CCA communities. (DRR and CCA).

- Limited links between the different types of knowledge domain and work of both DRR and CCA communities (barrier for communication, joint programming and collaboration).
- Unavailability of information about the concrete effects of climate change at on the local level (see 7.4.5.1 on Knowledge Creation).
- Limited census based information on of relevant census data (social and economic parameters, particularly in the areas) especially in dynamic areas such as high fluctuations of people, economic instability etc.
- The existing workload limits does not allow for the familiarization with yet another cross-cutting issue to be mainstreamed into daily work.
- Lack of information on of the societal and political structures in the target area often leads to a failure in identifying and addressing the right stakeholders which eventually turns into unsuccessful and ineffective programs.
- Scientific knowledge on of climate change acquired by the scientific community has not translated or communicated trickled down to practitioners or it is communicated in a way that is hard to understand and derive practical knowledge of (see 7.4.5.2 subsection on Constraints in Knowledge Sharing and Dissemination).
- Donors practices and funding guidelines have not yet explicitly and extensively established linkages of adaptation with DRR. This has potentially discouraged the recipient organisations working on DRR not to include adaptation strategies into their proposals and vice versa.
- There exists a gap between theoretical knowledge about on mainstreaming and their applications. So far mainstreaming is not being put into practice.
- Lack of substantive knowledge and guidance in the treatment of how to deal with the aspect of uncertainty in climate change projections .
- Absence or lack of methods, standards and tools on how to mainstream CCA and DRR into other fields or potential sectors of development practice.
- Lack of appropriate indicators that could help in the process of effective for climate screening of ongoing projects and also in the formulation of climate smart/proofing of ongoing or future projects.
- Absence or lack of appropriate indicators for assessment that could measure successful adaptation and which could also be integrated incorporated into funding guidelines as well as monitoring and evaluation strategies (ICSU 2010).

This list of challenges and constraints (German Committee for Disaster Reduction 2009) is based upon an extensive literature survey and assessment and on interviews with a worldwide selection of 59 experts from all continents, the Pacific and Caribbean islands and covering a wide diversity of expertise. It gives rise a list of 36 recommendations many of which specify a need for research linking DRR and CCA.

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 (Commission on Climate Change and Development, 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). There is a sense of concern amongst the disaster risk reduction community about the much higher degree of political and public recognition that is given to climate change (Tearfund 2008), and a concern that funding for adaptation to climate change will be at the expense of disaster risk reduction (Mercer 2010). 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. It has also been asserted that it would be politically expedient to draw upon this in accessing resources for disaster risk reduction both in terms of funding streams and political prominence (Mercer 2010).

A second view is adopted by many in the climate change adaptation community. They recognise a diversity of cross-cuttings risks that can be associated with the impacts of climate change and consider disaster risk reduction 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, Lewis 2007, O'Brien et. al. 2006, Christoplos et al 2009, CCD 2009, UN ISDR 2009a).

At the practical level there are many steps already underway to bring about such forms of integration (See Chapters 5 and 6). The 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 above 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 on a Spatial Scale

The literature reflects a view that DRR and CCA operate on 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 on a larger spatial scale (See Chapters 4 and 6and 7.2.1 above).

One commonly cited impediment to integration is that climate change projections do not provide precise information on a local scale (See chapter 3 above) and that adaptation strategies tend to be designed for entire countries or regions (German Adaptation Strategy to Climate Change 2008, Red Cross/red Crescent climate Centre 2007). There is also a difference in scale between the sources of disasters and climate change. There is a spatial mismatch between those countries that are primarily responsible for climate change and those that carry the burden of impacts resulting from, for example, more extreme weather events. This scale difference is associated with quite different views about international action for DRR than for CCA associated with global justice and security (Birkmann and von Teichman 2010).

7.6.3. Integration on a Temporal Scale

There is also a perceived difference in the temporal scales of CCA and DRR. The disaster community has traditionally been focussed on humanitarian response including relief and reconstruction in the relatively short term. (UN ISDR 2009b), whereas climate change and CCA have been recognized primarily as long-term processes with projections extending from decades to centuries (See Chapter 3 above) which poses problems to development communities usually with 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 on 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 ISDR. 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 "strategy". 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 towards a stronger mitigation or DRR approach. (Burton 2003). Similarly climate change was initially conceived as an atmospheric pollution issue 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 international climate regime (UNFCCC) is linked at the national level to environment ministries, whereas the disaster regime (ISDR) is linked to emergency planning and preparedness agencies or as in other cases to the office of President. Neither DRR nor CAA are well linked into economic planning and development agencies (UN ISDR 2009).

There is also a "top-down" versus "bottom-up" distinction (Hare et. al. 2012, 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 above. 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 for the two exists in both, at the international level where DRR has progressed and at the national- and local level where CC is moving to.

7.6.5. Towards More Integration

An assumption of this Special Report is that CCA could be enhanced by learning from the experience of the DRR community. 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 integrated into development (UN ISDR 2009a). 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 Reports 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 DRR and CCA) led for example by ICSU on the need for integrated approaches (across various natural and social sciences and including co-production of knowledge with stakeholders) to environmental issues to be carried out under new institutional arrangements to provide relevant knowledge to policy makers for sustainable development. Whether closer cooperation in DRR and CCA could also lead to institutional change is a moot question, but it has been observed that the Hyogo Framework has been designed with a set of goals, activities and policy measures, for a 10 year period to end in 2015, (Tearfund 2008) and that the next major IPCC Assessment (the 5th Assessment) is due to be released in 2014. The proximate timing of these two events, falling hard on the heels of the Rio Plus 20 Conference in 2012 might provide opportunities for further moves towards cooperation between the DRR and the CCA communities.

Frequently Asked Questions (FAQs)

1) Why has climate change adaptation received more visibility at the international level than disaster risk reduction?

Climate change is a problem affecting the global public good of the whole atmosphere. All countries stand to be affected, whereas disasters are less "universal" in that they are perceived to affect nations mostly one at a time.

There is a stronger sense of collective global responsibility for climate change since the problem was created in the first place by the more developed countries. There has been a legal guarantee under the Climate Convention to provide funds for adaptation. No such undertaking has been made in the disaster risk reduction, and such funds that do become available have historically been used more for post-disaster emergency response than for anticipatory risk reduction.

2) Why is it difficult to implement DRR and CCA, and why do we continue to allocate many resources at the international level to disaster relief compared with DRR ?

The DRR and the Climate Change communities have evolved separately from different sectors or disciplines. Typically, many DRR practitioners come from emergency management, architecture, engineering, geographical studies etc., while a large proportion of CCA personnel come from the climate, meteorology and economics etc. Therefore the merging of programmes requires mutual education and committed teamwork between practitioners from diverse sectors. A further problem relates to the separate placement of DRR and CCA within different governmental structures, often described as freestanding 'silos'.

For example, disaster risk reduction may emerge from housing ministries, urban and international development and agriculture, while adaptation to climate change may be the province of departments of environment, energy or meteorology. The third reason relates to the reality that both DRR and CCA require sustainable solutions and this requirement inevitably presents a massive and long-term implementation challenge to all assisting groups.

Disaster relief consumes large international resources for varied reasons: first, the critical humanitarian need provides an urgent imperative that is impossible to ignore; second there is a continual escalation in the scale of disaster impact; third, the pressure of the global media creates an insistent demand for concerted and massive response, and fourth, the presence and pressure from the vast international NGO community and their supporters is fuelled by an outpouring of human compassion resulting in donations. Further disasters are considered to be short term while DRR and CAA are long term and hence better placed within the development goals of a country than relying on short term outside interventions as in a disaster.

3) Can disaster risk reduction and climate change adaptation be better harmonized at the international level, if so how?

Yes. Climate change and extreme events share inter-related causal mechanisms and vulnerability factors, and also significant overlap in terms of the international institutions, technical, and financial resources available to manage them. However, real efforts at harmonization have only occurred over the last five years or so, and CCA, DRM and poverty reduction are still considered to be poorly co-ordinated. Independent evaluations have shown that the main international agencies have made good progress in linking the issues in terms of defining policy goals, and awareness raising and advocacy. The main weaknesses, and therefore opportunities for improved harmonization in the future, are in inter-agency coordination, implementation, and sustained engagement at the national and local level.

4) Why should the international community become involved in insurance?

Losses from extreme weather often cross national borders and can be of such scale that local/national insurers cannot absorb them. If reinsurers fill this gap, then there is little need to involve international organizations or NGOs. However, the global reinsurance market can fail to provide the capital at a price necessary for local and national insurers to provide cover to the most vulnerable. Reinsurance premiums are typically significantly higher that the actuarial fair value (expected losses to the insurer), which means that premiums become ill affordable to low-income households and farmers. The World Bank, as an example, has responded to the high cost of commercial reinsurance by offering lower cost capital backups to public and private insurers, such as in Mongolia and Peru. The international community can provide other services to address market failure, such as building weather stations that are needed for index-based weather insurance. Finally, international organizations, such as the World Food Programme, may themselves want to insure their potential post-disaster liabilities.

5) What will happen with the availability and cost of insurance when combining the objectives of CCA and DRR?

CCA has added a new dimension to the provision of insurance to the most vulnerable. Because of mounting evidence that climate change may be influencing the frequency and severity of some types of weather extremes, there is increased interest on the part of international development and other organizations to provide security to the vulnerable. This strengthens the case for supporting insurance systems in the developing world, making them more available and affordable to the poor. There is also keen interest in both CCA and DRR communities to link insurance with disaster risk reduction, as evidenced by recent pilot programs, for example in Ethiopia, where farmers who contribute labour to reducing drought risks are compensated with lower insurance premiums.

6) How can the international frameworks become more adept/successful in reaching the local level directly and through national governments and regional organizations?

By their very nature, international frameworks tend to be broad-based. They are useful in establishing a shared global viewpoint on international issues. But in order for them to drill down to local levels, sometimes they have to be complemented by national and sub-national frameworks and actions that stay true to the spirit of international frameworks but are tailored to specific domestic and local circumstances.

7) Are existing institutions for deployment of financial resources adequate for managing current and future disaster risk?

There are an expending number of sources (windows) for financial assistance (grants and loans) and a growing number of implementing agencies, as well as the trend towards “direct access”. The growth in funds is providing more opportunities to finance climate change adaptation. This is much less the case for DRR. At the same time the multiplicity of funds and sources makes access more complicated and creates bureaucratic impediments and coordination issues.

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Table 7-1: Estimated Annual adaptation costs in developing countries.

	Assessment Year	USD (Billion)	Time Frame
UNDP	2007	86	2015
UNFCCC	2007	28-67	2030
OXFAM	2007	50	Present
World Bank	2007	9-41	Present

Sources: Human Development Report, UNDP (2007); Economic Aspects of Adaptation to Climate Change: Costs, Benefits, and Policy Instruments, OECD (2008)