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

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Note to Expert Reviewers

Working over the past 6 months on the First-Order Draft (FOD) of SREX Chapter 7 (Managing the Risks: International Level and Integration Across Scales) has been a learning experience for all the authors. At this time we wish to acknowledge and point out some of what we consider to be the weaknesses in the draft, and specifically request comments and suggestions from you that will help us to improve the Second-Order Draft. We wish to draw your attention to seven points. This is of course without prejudice to any other comments you may wish to make.

1) The FOD is about right for total length as allocated. Additions and expansions can be made but only to the extent that an equal amount of existing text is reduced or deleted.
2) Perhaps our biggest realization has been that this topic as given to us in the IPCC approved outline is very large indeed. We need to find ways and a good rationale for making the chapter more focused, and limiting its scope to the really crucial issues. We would welcome your guidance on how best to do this, and what changes you consider would be most helpful. We are sure that this will entail cutting out some of the text, and perhaps this will be easier when authors review the contents of the other FOD chapters. In addition to suggestions for cutting and focusing we are of course open to proposals for additional material that has so far been overlooking or otherwise omitted. If additional material or topics/issues are suggested we would welcome citation to the additional literature that should be examined.
3) We are conscious of the fact that the chapter does not have a good "flow". Another way of saying this is that it lacks continuity and integration and a good "storyline". Comments and suggestions would be welcome.
4) The chapter is too heavy on the description of international management frameworks and institutions, and is lacking in assessment. One reason for this is that there appears to be very little "assessment" literature that is publicly accessible and in peer-reviewed journals, and that there is a very large volume of both descriptive and prescriptive literature. In consequence many of our references are drawn from the grey literature. We are in desperate need of more peer-reviewed literature with a potential for strengthening the "knowledge assessment" content of the chapter. Suggestions and advice are needed and welcome.
5) This latter point applies especially to Sections 7.4, 7.5, and 7.6. We are conscious of weakness in these sections and invite suggestions of ways of strengthening them and suggestion of other quality and/or peer-reviewed literature. In particular we would welcome suggestions of additional material on Section 7.5 (Considerations for Future Policy and Research) and 7.6 (Integration Across Scales).
6) Given the broad nature of the subject matter of Chapter 7 we find that the expertise on our team (while excellent in all respects) falls short of the wide range of expertise on which we need to draw. We are open therefore to the suggestion (or volunteering) of additional "contributing authors".
7) One idea that is being discussed in relation to some of the above points is to treat the topic of "international level management" in a more evolutionary manner giving attention to the history or time line of the development of institutions and principles. While this would not be strictly evaluative it might perhaps help to create a better sense of understanding of the directions in which management at the international level has been moving for both DRM and CCA. It is not the intention to make this a basis for "policy prescription", but to help identify future options and opportunities and research needs and knowledge gaps. Reactions welcome.

Contents

Executive Summary

There are compelling reasons and principles of international governance why substantial efforts are required at the international level to reduce weather and climate – related disaster risks and promote across scales adaptation to extreme events associated with climate change.

Two of the main institutional frameworks are the International Strategy for Disaster Reduction (ISDR) and the adaptation elements in the United Nations Framework Convention on Climate Change (UNFCCC). The ISDR and UNFCCC efforts to develop a management approach have been developed largely along separate and independent tracks.

While disaster risk management (DRM) has received considerable attention recently through ISDR and other organizations and institutions, the results in terms of number and size of weather and climate-related disasters including property losses and numbers of people affected has not been encouraging. According to Munich Re data, trends in overall losses and insured losses from great natural catastrophes have continued to increase although fatalities per event have decreased.

Climate change adaptation (CCA) has been prominent on the international agenda for a much shorter period of time than DRM. There are still wide ranging debates how adaptation should be approached in the international area, including its link to overall development. As a result, systems of management and governance of adaptation are still

being formulated. On the other, DRM has recently have had to review its strategy in the light of changing patterns of hazards and risks and growing inequalities.

Both DRM and CCA face significant obstacles if they are to advance towards greater success and operational effectiveness in creating less risky and more resilient communities and nations. There are governance and legal obstacles, estimating costs of damages and financial constraints, the availability and distribution of technology and management capacity, and in the means of risk transfer and sharing. In all these cases there are considerable opportunities which could be made available by reducing the existing constraints and by the development of new creative and integrative approaches.

There is a strong prima facie case to be made for bringing DRM and CCA closer together in a more integrated and synergistic approach. They have much to learn from each other. It is also the case that successful DRM and CCA cannot be achieved in isolation from other institutions and management capacities and that much depends on development choices and pathways.

Much might be achieved on the basis of present knowledge and its more effective deployment. At the same time it is clear that many questions remain unanswered and sometimes not asked. Despite the growth in knowledge (or maybe because of it) uncertainty will remain high, and there is a large agenda for future research.

Globalization and the closer integration of the world economy and social interactions of many kinds proceed apace. Changes in finance, communications, trade, patterns of economic growth, (among others) are changing the nature of disaster risk. Continued growth of greenhouse gas emissions means that much better understanding of the processes of adaptation is needed although adaptation will be a solution only up to some extent. This applies at the practical and operational level and at a more fundamental level of theory. Several prominent research needs and directions are identified.

While closer integration between DRM and CCA is needed at the international level, the same applies at the local and national levels where its link to addressing the MDGs and sustainable development are to be realised. Most important for the development of better management of DRM and CCA is the need to integrate and harmonize across scales between local, national and international. To achieve this requires an improvement of both bottom-up and top-down flows of knowledge, finance, technology, institutional frameworks, legal instruments, and the strengthening of mutual trust and confidence.

Literature also shows that existing tools and instruments of international law can assist with disaster risk reduction and management and in driving adaptation to climate change. However, international law is limited in scope and enforceability when applied to addressing these same challenges. The international legal status of instrumental policy frameworks on climate extremes i.e. the UNFCCC, the HFA and the MDGs are not identical and as a result these policy frameworks continue to operate parallel to each other resulting in duplication and sometimes contradicting efforts.

[NOTE: The Executive Summary will also include information on the overarching questions identified in Section 7.1.1 and relevant conclusions.]

7.1. The International Level of Risk Management

This chapter brings together and assesses the knowledge from two domains of expertise: disaster risk reduction (DRR) and climate change adaptation (CCA) at the international level. It seeks to identify the lessons that can be learned from disaster risk reduction (largely in the absence of anthropogenic climate change) and to assess how DRR experience might help to inform and guide the rapidly growing practice of climate change adaptation. Similarly climate change, especially the changing pattern of climate extremes, poses a new challenge for disaster risk management (DRM). The interaction of DRR and CCA applies at all spatial scales and governmental levels of risk management. This chapter also addresses the topic of integration across scales.

7.1.1. Overarching Questions

A first question concerns the rationale for DRM and CCA at the international level. On what grounds are these problems managed partly at the international level? The second question concerns the development of institutions and institutional capacity at the international level. What institutions exist and what capacity do they have? A third question concerns the management constraints and opportunities for DRR and CCA. What exists and what are the possibilities for the future? A fourth question concerns the gaps in knowledge. What is being done and needs to be done about further knowledge creation and its relation to policy needs? The last section of this chapter then turns to the question of integration across scales

As outlined in Section 7.3. the reduction of mortality and morbidity and property losses from weather and climate-related disasters has been a major concern of the international community for some decades at least. The Global Assessment Report on Disaster Risk Reduction (GAR) (2009) acknowledged that climate change is a global driver of disaster risk. GAR (2009) notes that weather-related disaster risk is escalating swiftly both in terms of the regions affected, frequency of events and losses reported and that climate change is changing the geographic distribution of these weather-related hazards, threatening to weaken the resilience of poorer countries, their community's ability to absorb losses and recover from disaster impacts. Although continuous improvement in early warning systems and a number of other international programmes and organizational responses have been highly effective in reducing risks (Global Network, 2009), losses are still significant (see Chapter 4). The following data from Munich Re provide one widely quoted source of information about the losses as estimated in U.S. dollars (see Figure 7-1). While there are many legitimate questions about the accuracy of the data and its interpretation (i.e., that there are variations between years), there is little doubt about the overall trend over time (Goklany 2006; Hoppe and Pielke eds, 2006). These estimates are a gross underestimation of for instance, the role of the cumulative effect of both major and minor events on increasing poverty globally indicating that the long term material and mortality losses linked to disaster is not known.

[INSERT FIGURE 7-1 HERE:
Figure 7-1: Overall and Insured Losses from Great Natural Catastrophes 1950-2006 Source: Munich-Re (2007)

At a global scale the results in terms of mortality and morbidity have been much better, and although the numbers affected by disasters has continued to increase the actually number of fatalities per disaster has declined. Nevertheless developing countries continue to record high mortality and losses relative to their GDPs compared to the developed nations (see Figure 7-2).

[INSERT FIGURE 7-2 HERE:
Figure 7-2: Differential burden of natural disasters according to country income groups. Source: Linnerooth-Bayer, et al., 2010 (based on data from Munich Re, 2005). (Note: country income groups according to World Bank classification)]

Many indicators of disaster losses have worsened in recent years, despite rapidly expanding scientific knowledge about the risks, increased global interconnectivity and flow of information and major international efforts in DRM. Climate change is expected to increase hazards, and all other things being equal, human and economic losses (see Chapters 3 and 4 and Section 7.4). This leads to the question "why in a period of rapidly expanding scientific knowledge about the risks, increased global interconnectivity and flow of information and major international efforts in DRR have losses continued to increase?" (White, Kates, and Burton. 2001). Similarly it should be asked what might be done at the international level to prevent losses rising even more rapidly in an era of climate change, and how climate change adaptation might be promoted, supported and implemented in such a way that disaster losses are reduced or at least the rate of increase is lowered. Could it possibly be that the knowledge and experience of DRR when combined with CCA and linked to development could in fact achieve more positive results that either seem to be achieving at present?

It is important to enter the qualification that not all DRM elates to climate change and not all CCA relates to disasters. For example a major concern of the DRM community is with earthquakes, tsunamis and other

geophysical, conflicts and technological events that are not generally related to climate change. Similarly the CCA community has to be concerned with the slow incremental consequences of climate change such as sea level rise and the expansion of the arid regions and the pace of desertification. Despite the different time scales involved the risks are not entirely unrelated. If drought events increase in severity or duration (or both) as seems likely with climate change in some places (Chapters 3 and 4) then periodic and intermittent drought disasters may be slowly transformed into a permanent and ongoing challenge for adaptation, either in situ or by relocation. Similarly tropical cyclones may become more severe as sea level rises and as ocean surfaces become warmer (Chapter 3).

Chapters 5 and 6 have addressed these questions by examining the reported strengths and achievements of local communities and national governments while Chapter 8 examines the linkages between DRR and development. In this chapter, we turn to examining responsibility at the international scale and their effectiveness in managing climate extremes. Two caveats are in order. First there is an intentional focus on disaster risk management as a governmental function. The public sector is the main focus of negotiation and regulation of international response and management. Less attention is given to the private sector; to the individual or the household; and to humanitarian non-governmental organizations. For example in the private sector, the Global Disaster Resource Network is a global network of companies in the engineering, construction, logistics and transportation sectors that are committed to assisting humanitarian organisations resources free of charge. Dunfee and Hess (2000) have shown that the private sector has a comparative advantage in humanitarian efforts through their business culture for instance in high levels of efficiency, lower cases of corruption due to their vulnerability to competitive pressure. The private sector also has a role in long term disaster risk management for instance microcredit arrangements and education sponsorships. At all three governmental levels however the questions are addressed – where is the boundary between public (governmental) and private sector action and responsibility, and similarly between government and the private citizen or household, and non-governmental or civil society organizations? These questions raise the issue of greater focus on creating partnership at various levels between the different government entities (Warhurst, 2005).

The second caveat concerns the simple division into local, national, and global. There are other levels of government and governance. Often the villages and communities at lowest level of “governance” are grouped into larger regions. Then there are major cities and metropolitan regions. In states and countries with large territories and federal constitutions there are also “state”, “provincial” or other sub-national levels of government. Beyond the strictly national level there are many kinds of bilateral and multilateral arrangements, formal and informal, for the management of trans-boundary risks, or for the management of shared ecosystems or river basins (Linnerooth-Bayer et al, 2001). “International” does not necessarily mean global, but there is a global dimension. Climate change and its associated extremes constitute a set of risks that are clearly global if only in the sense that all of humanity is being or will be impacted by changes in the climate system and the global atmosphere. The earth’s atmosphere is the ultimate common property resource cutting across all scales.

7.1.2. Elements of Management

This chapter addresses the overarching questions in sequence. First the main elements of and principles that are used to justify international response are described in Section 7.2. This discussion provides the existing rationale for action at the international level. It is shown that this has evolved from a largely humanitarian approach towards consideration of principles and ethics. The need for international action has also increased with the greater integration of the world economy (globalization and systemic risks), and with the world-wide impacts of climate change which raise dangers of major economic inefficiency, and growth in inequity. The UNFCCC itself has moved the debate increasingly in the direction of international law, to the point of considering the nature of international responsibilities and obligations.

Secondly the chapter describes and assesses the current international governance and institutions (Section 7.3) for DRM and CAA. There is now a rich mosaic of frameworks and organizations including not only those specifically directed towards CCA and DRM, but also many other components of the international governance system. Climate change is a globally pervasive phenomenon in which all human institutions are to some degree involved. Section 7.4 addresses the third issue; that of constraints that hinder the development of more effective DRM and the

implementation of effective CCA practices. Section 7.4 also identifies opportunities in expanded financing, technology development, and risk sharing and transfer, including various forms of insurance. The questions of knowledge generation and sharing for DRM and CCA are also addressed.

7.1.3. Potential to Reduce Exposure and Vulnerability at the International Level

Although climate extremes have a negative effect they help to raise consciousness of climate change within the public and policymakers. This can then provide further 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 P. and 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). The long term potential to reducing exposure to climate risks lies in sustainable development (O'Brien et al, 2008)

7.1.4. The Role of DRM and CCA at the International Level in Building a Sustainable and Resilient Future

Adaptation is defined as "an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2001) while DRR is defined as "the broad development and application of policies, strategies and practices to minimise vulnerabilities and disaster risks throughout society, through prevention, mitigation and preparedness" (UN ISDR, 2007). Although each extends beyond the scope of the other both seek to build resilience through sustainable development (O'Brien et al., 2008). This supports the need for DRM to be a key component in the ongoing UNFCCC climate negotiations as recognised in the Bali Action Plan (BAP). (UNFCCC – Bali Action Plan COP 13 2007) Disaster risk management could be realised through increased awareness and understanding of synergies and differences in CCA and DRR, and by providing a framework for integration in areas of overlap between the two (Venton P.and Trobe, 2008). The World Conference on Disaster Reduction (WCDR) held in Kobe, Japan in 2005 and the BAP point to the need for incorporation of measures that reduce climate change disasters with in DRR. Integration of the relevant aspects of DRR and CCA can be facilitated by using the Hyogo Framework for Action (HFA) 2005–20152 agreed by 168 governments in Kobe, Hyogo, Japan in 2005. International support in terms of for example institutional changes and pilot projects focusing on systematic integration of disaster risk management and climate change adaptation care other mechanisms of facilitating a move towards building of resilient societies.

7.1.5. Other Related International Activities

Anthropogenic climate change is a globally pervasive phenomenon, affecting all sectors of human society, including the economic, financial and social dimensions. Climate change also affects managed and unmanaged ecosystems. It is not therefore a public policy issue which can be cordoned off and left to a small number of specific and dedicated organizations and agencies to manage. The operations of all UN Specialized Agencies and many other international bodies are likely to be impacted by climate change in varying degrees, and the operations of all are also subject to extreme events and disasters. It is beyond the scope of this chapter and this report to address in any detail all these other related international activities. A select few are described in Section 7.3.4 to illustrate the scope of international involvement.

7.2. Rationale for International Action

The pattern of responsibilities for DRM and CCA at the local, national and international scales has evolved over time as the nature and magnitude of the risks have changed, as the capabilities of the various levels of governance have also changed, and as the architecture of international governance has been constructed over recent decades. Nevertheless it is possible to discern guiding elements and principles that have been used to guide and justify, as well as constrain, the allocation of responsibilities.

This section examines these guiding elements and principles as they have been articulated and applied for DRM and CCA, and codified into international practice and international law. This report focus mainly on the international level of human organization and governance and describes principles of subsidiarity, solidarity, and efficiency, as well as the reality of dependent and systemic risks, as they have shaped international discourse, practices and legal frameworks.

7.2.1. Subsidiarity

Subsidiarity is based on the concept that decisions of government (other things being equal) are best made and implemented, if possible, at the lowest most decentralized level closest to the citizen. While the principle of subsidiarity can be traced back to the Treaty of Rome (1957), it was specifically articulated in Article 5 of the Treaty of Maastricht on European Union in 1992 (The Maastricht Treaty, 1992). The intent of multi-level governance is thus that the centralized governing structure should only take action if deemed more effective or necessary or otherwise than action at a lower level; it requires cooperation between all levels of government (Jordan, 2000). Subsidiarity is designed to strengthen accountability and reduce the dangers of making decisions in places remote from their point of application. The principle does not necessarily limit or constrain the action of higher orders of government, it merely counsels against the unnecessary assumption of responsibilities at a higher level (Begg, 2008). In the case of the risk management of climate extremes, major weather and climate events such as tropical cyclones, large floods and droughts can quickly overwhelm the capacity of local governments to respond. Weather events also frequently affect more than one community, resulting in the need for national level response. This commonly applies especially to the poorest and least developed nations.

Subsidiarity also recognizes the importance of harmonizing actions in an integrated way across governing levels. For example, 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 being 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. These interactions can both enhance or constrain coping and risk management. While many regions and river basins, for instance, are required to develop risk management flood plans, flood protection is predominantly a national (and in many countries, e.g., Germany and India), a state responsibility. The principle implies that international or national level involvement should only apply to cross-border catchment areas (Stoiber, 2006). Disaster and climate financing in terms of subsidiarity means that matters should be managed by the lowest level that demonstrates relevant competency (Craeynest, et al., 2010); however, the evaluation of the competency may be assumed at a higher level. Ideally, the principle of subsidiarity should be used as a tool to protect against infringing on local level intervention or support (Gupta and Grubb, 2000).

Also according to the principle, national level strategies for disaster management and adaptation plans should be developed with the participation of regional or local level decision makers. This active engagement at all levels is necessary to help identify the most suitable measures for proper governance and implementation.

7.2.2. Solidarity

When the management or coping capacity of lower levels of government is exceeded then higher levels can be involved on the basis of a formal or informal social contract. This applies especially to post-disaster response. Our common humanity leads people to care for each other especially in times of crisis or adversity. The rapid expansion of global communications in the latter half of the 20th Century has enabled many more people to receive reports and see pictures of disaster scenes everywhere in the world. There has been a corresponding growth in per capita voluntary contributions to humanitarian assistance in disaster situations. National governments as part of their governing mandate come to the aid of communities and sub-national levels. Nations cooperate and help each other when their individual capacities are stretched or exceeded. And at the global level, voluntary actions and multilateral agreements are created to facilitate the identification, planning and execution of modes of mutual assistance, and in some cases to propose or mandate the allocation of responsibilities. Recently, the principle of solidarity underlying post-disaster humanitarian assistance has been extended to providing assistance for pre-disaster interventions that reduce and transfer risk (Kreimer and Arnold, 2000).

With growing globalisation the principle of solidarity is further enhanced as offers of e.g. 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).

7.2.2.1. Common Humanity

Values that define our common humanity have been most cogently expressed through the eight Millennium Development Goals (MDGs), which respond to the world's main development challenges. The MDGs are drawn from the actions and targets contained in the Millennium Declaration that was adopted by 189 nations-and signed by 147 heads of state and governments during the UN Millennium Summit in September 2000. In the words of the Declaration:

> *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 are four times more likely to die due to natural disasters, and the cost per disaster as a share of GDP is much higher than in OECD countries (Barnett et al, 2008). Between 1991 and 2001 there were 1,052 deaths per disaster in countries with low human development indexes (HDI) compared to only 23 for high HDI countries. Moreover, increasing frequency, magnitude and spatial coverage of climate extremes (see Chapter 3) mean losses are fast exceeding the capability of many individual countries to manage the risk (Rodriguez et al, 2009). It is well established across a large literature 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).

Weather extremes constrain progress towards meeting the MDGs , especially the goal of eradicating extreme poverty and hunger (UNDP, 2002; Mirza, 2003; HDR 2007/2008, 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. (2008) have shown that the poor's ex ante risk management strategies commonly tradeoff expected gains such as investing in fertilizers or improved seed to reduce risk of suffering catastrophic loss, a situation perpetuating the "poverty trap". The poor are frequently subjected to double or multiple exposure from climate change and other stesses 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. Humanitarian assistance, although essential for upholding this principle, 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).

7.2.2.2. Principled Responsibility

Beyond a sense of common human concern, and expressions of solidarity in the MGDs it has been pointed out that countries contributing most to climate change have a "principled" obligation to support those who are most vulnerable and who have had limited contribution to the problem. This is the claim underlying the notion of Common but Differentiated Responsibility (CBDR), which has emerged as a principle of international environmental law 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]

The CBDR informs in particular the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, but mainly with respect to mitigation. The CBDR can be said, in synthesis, to express the need to evaluate responsibility for the remediation or mitigation of environmental degradation based on both historical contribution to a given environmental problem and present capabilities: it is a guiding principle of international cooperation and solidarity (De Lucia, 2007).

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. Some of this literature examines principles for compensation as a result of imposed harm. Farber (2007, 2008), Delink et al. (2009) and Grasso (2010) review potential arguments over who is responsible and who should pay for adaptation. Farber (2007) suggests that potential principles for allocation of responsibility include: a) compensation by the beneficiaries of the adaptation and that if benefits are localized, there is no justification for international transfer; 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' (rather than be harmed) from the impacts of climate change. These principles have received some attention in diverse literatures. Farber (2007) dismisses principle d) as the likely winners from climate change are not widespread and concludes that having emitters pay for adaptation (in effect the polluter pays principle) has greatest normative appeal, but also suggests significant benefits and feasibility of global compensation and risk spreading.

Another set of literature suggests that adaptation to human-induced climate change is categorically different to previous adaptation to risk in that it involves the avoidance of harm imposed by others (e.g. Caney, 2010; Adger et al. 2009). Caney (2008) makes the case that equity issues around climate change can be framed as the right 'not to suffer from dangerous climate change' (p. 537) or as 'rights to avoid dangerous climate change' (Adger, 2004). Climate change impacts jeopardise fundamental interests of individuals in their life and livelihoods (such as impacts on disease burden, malnutrition and food security): rights to life, health and subsistence as a minimum set. Caney (2010) also discusses a right 'not to be forcibly evicted' (p. 83) as a potential further undeniable right. This literature suggests that fundamental interests are significant enough, and universal enough to warrant obligations on others, even without recourse to the polluters pays principle. As Caney points out, this strong case for rights in this area are amplified if consideration is given to both future generations and the natural world. 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, but can be taken to apply to climate related disasters where 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 3.3).

7.2.3. Systemic Risks

Risks from extreme events can be far reaching. Large regions including groups of several countries may be directly affected by climate-related hazards. For example, between 2006 and 2007 two consecutive positive Indian Ocean Dipole (pIOD) events caused far-reaching climate and societal impacts in regions and countries, including: Australia, where exceptionally long lasting droughts were experienced; East Asia and South India, where floods resulted in high mortality; Indonesia, which experienced unprecedented wildfires; and Europe, which experienced dry and warm anomalies (Luo et al., 2008). Moreover, the risks are not independent from each other but co-variant, which means that their management may require risk reduction and risk sharing mechanisms that reach across borders. For example, if insurers with limited capital reserves choose to indemnify large co-variant and recurring risks, they must guard against insolvency by diversifying their portfolios geographically, limiting exposure and/or transferring their risks to the global reinsurance and financial markets (Mechler and Linnerooth-Bayer, 2006). 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 with world wide and systemic effects. 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. The impacts can also be felt globally through impacts on international trade and human relocation and migration.

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. Climate-related disaster risks can be systemic as the impacts of a less direct nature cascade beyond the immediate region affected. Relationships and connections involving the movement of goods (trade), finance (capital flows and remittances), and people (displaced populations) can extend to continents and indeed to the world as a whole Normally, in the past, the amplification of such events beyond the region in which the disaster occurs has been minimal and short lived, essentially because the global economic system has been sufficiently loosely coupled to absorb major shocks that have occurred without significant ripple effects. 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 extent of these impacts is not well documented. 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).

Disaster events can also result in the temporary or permanent displacement of hundreds or thousands or more people sometimes across international borders. 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). Evidence on the extent of current and future disaster- and climate-change induced migration is debated (Myers, 2005; Morrissey, 2009; Guzman, 2009). It is difficult to disentangle the drivers of migration, including climate change risks, rising poverty, urbanization, spread of infectious diseases such as HIV/AIDS, and conflict (Thomalla et al., 2006; Barnett, and Adger 2007; CIENS, 2007). To the extent that weather extremes contribute to migration, it can result in a huge burden to the destination areas where the capacity of the area to provide essential services may be threatened, the potential for disease transmission heightened and when combined with loss of social support systems the process may deepen poverty and increase further vulnerability to even usually low risk weather events (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 is not known and continues to be a source of concern prompting the need for international intervention (Barnett and Adger, 2007; Heltberg et al., 2008;Warner et al., 2009; Tacoli, 2009).

7.2.4. 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 missing and misaligned markets ((p. 467), and that international transfers are justified on the basis of the principles of interdependence of the world economy (discussed above) and the public good nature of many risk management interventions, for example, implementing regional warning systems and collecting climate data. Tompkins and Adger (2005), Berkhout (2007) and others discuss how some areas, such as water resources, change from being public to private depending on national regulations and circumstances, thereby questioning the strength of the public good principle for adaptation. Nevertheless, the principles of interdependence and public goods suggested by Stern and others are widely adopted and shared within the literature on international responsibility (Vernon, 2008; World Bank, 2010; Gupta et al., 2010).

In addition to the public good nature of many adaptation measures, there are also economic efficiency grounds for international cooperation. Early warning systems, as an example, may be conceived as nationally based, but many warning systems depend on regional and international cooperation to secure the exchange of necessary data. This is not straightforward, however, as sovereign states can view their data as having strategic or commercial value, and for these reasons can deny or limit its exchange. In the field of meteorology, many years of discussion under the auspices of the World Meteorological Organization (WMO) have led to formal agreements on the types of data that are routinely exchanged (WMO 1995). 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).

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 assessed in details by Verheyen 2004. 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 (Office of the High Commissioner, 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 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 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. And at article 3.14, UNFCCC's Kyoto Protocol calls specifically for the establishment of insurance.

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 *opinion 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 environment risks (Trouwbrst 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), as 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 Organsiations in Disaster Relief (1995) and the Sphere Project Humanitarian 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 (Fisher in *Tsunamis*…). 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 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 the development 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

7.3.1. Hyogo Framework for Action (HFA)

7.3.1.1. Description of HFA

In 1989, the United Nations General Assembly adopted a resolution that designated the1990s as the International Decade for Natural Disaster Reduction (IDNDR), demonstrating a commitment to disaster reduction. This was the first major collective international attempt to reduce disaster impact, particularly within hazard-prone developing countries (Wisner et al 2003 pp 323-325). Each country was encouraged to establish national committees, and over 120 were established. In 1994, the first proposal for disaster reduction was developed during the Yokohama Conference on Risk Reduction termed the Yokohama Strategy and Plan of Action, providing policy guidance with technical and scientific basis. In 2000, the IDNDR was followed by the United Nations International Strategy for Disaster Reduction (UN ISDR), which broadened the scope to include increased public commitment and linkages to

sustainable development. The approach of the ISDR system has been to promote the use and scaling up of tools and methods to reduce disaster risk while additionally encouraging the collaboration between disaster reduction and climate change by, for example, developing disaster risk reduction and adaptation planning and programming. Partners in the ISDR system engage in capacity-building for climate change and disaster risk reduction actions, awareness-raising at community and national levels, advocacy with climate change delegates to promote the integration of the disaster risk reduction approach in international climate policy, and the production and dissemination of risk assessment and management tools. The ISDR secretariat provides information and guidance on disaster risk reduction to manage climate risks and adapt to climate change, both to inform international policy deliberations and to assist governments and other parties to reduce climate-related vulnerabilities and risk. It undertakes global reviews of disaster risk and progress on risk reduction and facilitates the compilation, exchange, analysis and dissemination of good practices and lessons learned in disaster risk reduction. In January 2005, 168 governments supported the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters at the United Nations World Conference on Disaster Reduction in Kobe, Japan (WCDR). The Framework was unanimously endorsed by the UN General Assembly (UN ISDR, 2005a).

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 areas of Priorities for Action:

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

Note that 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" (UN ISDR 2005a).

7.3.1.2. Key Actors in HFA

Institutionally, ISDR is designed to create a system of partnerships composed of range of stakeholders with essential roles in supporting 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, the national governments play the most important roles for HFA implementation and are responsible for 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 are expected to promote programmes for disaster risk reduction; undertake and publish regional and sub-regional baseline assessments; coordinate reviews on progress toward implementing the Hyogo Framework within the region; establish regional collaborative centres; and support the development of regional early warning mechanisms. International organizations are intended to encourage integration of disaster risk reduction into humanitarian and sustainable development programmes and frameworks; strengthen the capacity of the United Nations system to assist disaster-prone developing countries with disaster risk reduction initiatives; support data collection and forecasting, information exchange, and early warning systems; supporting countries own efforts with coordinated international assistance; and, strengthen disaster management training and capacity building (UN ISDR, 2005b).

The UN ISDR Secretariat supports and assists the ISDR system in implementing the Hyogo Framework for Action.It is responsible for facilitating the coordination of actions at the international and regional levels; developing

indicators of progress to assist States in tracking their 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 toward achieving the Hyogo Framework objectives. (UN ISDR, 2009c).

7.3.1.3. Status of HFA

As a result of the adoption of the HFA, global efforts to address DRR have become more systematic. In 2009, the first biennial Global Assessment Report on Disaster Risk Reduction (GAR) was released. The report found that since the adoption of the HFA, progress towards decreasing disaster risk is varied. This variation is based on national agencies self-assessment of progress against the indicators defined in the HFA and hence are 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. The GAR findings continued to state that current DRR governance arrangements do not allow for the full integration of risk reduction into development. Further, at national and international levels, policy and institutional frameworks for climate change adaptation and poverty reduction are faintly connected to those for DRR. 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 (UN ISDR, 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 geographic 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 disaster risk (UN ISDR, 2009b).

In 2009, the Global Network of Civil Society Organisations for Disaster Reduction also released a report on the performance of the HFA; evaluating the progress on each of the five Priorities for Action (PFA) (GNCSODR 2009). The lowest level of progress across all the five PFA's was in community participation in decision making on DRR. 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. 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. Ecosystem management approaches can provide multiple benefits, including risk reduction and thus be a central part of such strategies. The policy and institutional frameworks for climate change and poverty reduction are only weakly connected to those for disaster risk reduction, at both the national and international levels. 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. Countries are making significant progress in strengthening capacities, institutional systems and legislation to address deficiencies in disaster preparedness and response (Global Network of Civil Society Organisations for Disaster Reduction, 2009; UN ISDR, 2009a).

7.3.2. United Nations Framework Convention on Climate Change (UNFCCC)

7.3.2.1. Description of UNFCCC

The UN Framework Convention on Climate Change (UNFCCC) is an intergovernmental treaty developed to address climate change. The rules, institutions and procedures have been described in details (Yamin and Depledge 2004) The Convention was negotiated from February 1991 to May 1992, and opended for signature at the June 1992 Rio Earth Summit (UN Conference on Environment and Development). Under the Convention, governments collect and share information on GHG emissions, national policies and best practices; launch national strategies for addressing GHG emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and cooperate in preparing for adaptation to the impacts of climate change.

Article 2 (the Objective of the Convention) states:

> "The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

The Principles of the Convention are outlined in *Article 3*. In their actions to achieve the objective of the Convention and to implement its provisions, the Parties shall be guided, inter alia, by the following:

1) The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.
2) The specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration.
3) The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties.
4) The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.
5) The Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change. Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.

Adaptation is specifically addressed in four places 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".

7.3.2.2. Key Actors in Adaptation under UNFCCC

The Convention divides countries into groups according to differing commitments: Annex I Parties include the those developed countries that in 1992 were members of the Organisation for Economic Co-operation and Development (OECD) and is extended to include countries with economies in transition (termed the EIT Parties). Annex II Parties exclude EIT Parties and consist only of the OECD members of Annex I. Non-Annex I Parties are mostly developing countries. Specifically, Annex II Parties are required by the Convention to provide financial resources to enable developing countries to carry out activities that reduce GHG emissions reduction and to assist them in adapting to the impacts of climate change. Additionally, Annex II Parties must advocate the development and transfer of environmentally friendly technologies to EIT Parties and developing countries. Select developing countries are recognized as being particularly vulnerable to the adverse effects of climate change; these include countries with low-lying coastal areas (Tuvalu) and those prone to desertification and drought (areas in Africa). Currently, 49 Parties are classified as least developed countries (LDCs) and given special priority under the Convention (UNFCCC 2009a).

Two key institutions engaged in climate change adaptation at the international level are IPCC, especially Working Group II (WG-II) and the Global Environment Facility (GEF):

- *IPCC Working Group II*: In 1988, an Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO) with the objective to assess the scientific, technical and socio-economic information relevant for the understanding of human induced climate change, its potential impacts and options for mitigation and adaptation. So far, four full assessment reports at interval of 3 to 7 years from 1995, guidelines and methodologies and a series of special and technical report have been completed by IPCC. Among the three working groups established by IPCC, Working Group II covers impacts, adaptation and vulnerability Working Group-II engages a group of scientists and experts, from diverse disciplines and regions, for systematic assessment of the scientific, technical, environmental, economic and social aspects of the vulnerability (sensitivity and adaptability) to climate change of, and the negative and positive consequences for, ecological systems, socio-economic sectors and human health, with an emphasis on regional sectoral and cross-sectoral issues.
- 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, and the Least Developed Countries Fund. 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.

7.3.2.3. Status of Climate Change Adaptation (CCA) under UNFCCC

The Conference of the Parties (COP) holds annual meetings to assess their progress towards meeting their Convention requirements. COP is the "supreme body" of the Convention, the highest decision-making authority and is responsible for negotiating international efforts to address climate change. The first COP occurred in 1995 in Berlin, Germany; it set the stage for the negotiations on the future Kyoto Protocol. In 1997, during COP 3 in Kyoto Japan the terms of the agreement were established (legally binding reductions in GHG emissions of 6-8% below 1990 levels by 2012) and would enter into force as a legally-binding agreement on the 16th of February 2005. By August 2009, the Protocol was ratified by 189 out of 191countries (the excluding countries are Somalia and the United States of America). In 2007 at COP 13, the Bali Action Plan was adopted (Decision 1/CP.13). The Plan includes adaptation as one of the 4 pillars of the agreement. During that meeting the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) was also established to conduct the negotiations. In December 2009, COP 15 (Copenhagen, Denmark) did not lead to a legally binding agreement as planned. Negotiations will continue in Cancun, Mexico during COP 16.

In 2001, the Adaptation Fund (AF) was established under the Kyoto Protocol and operationalized during COP13. The AF was created to finance on-the-ground adaptation projects and programmes in developing countries. The Fund is financed by a 2% levy on Clean Development Mechanism (CDM) projects and by voluntary donor contributions. Currently, an Adaptation Fund Board of 16 members and 16 alternates manage the AF, meeting biannually.

To support the least developing countries (LDCs) preparation and implementation of National Adaptation Programmes of Action (NAPAs), the Least Developed Countries Fund (LDCF) was established at COP-7. The fund is operated by the Global Environment Facility (GEF), and gives priority to adaptation. As of February 2010, the GEF has mobilized voluntary contributions of $194 million for the LDCF; 48 of 50 eligible LDCs have received a total of $10.6 million in support to prepare their NAPAs; and 36 NAPA implementation project proposals have been approved and had the necessary funding reserved (countries are allowed to submit more than one implementation project). A round total of $131 million has been approved (i.e. disbursed, committed, or allocated) for the implementation of concrete adaptation action in 33 LDCs (Denmark Ministry of Foreign Affairs 2009, GEF 2010).

7.3.3. Comparative Analysis : International Governance and Institutions

7.3.3.1. International Frameworks and Strategies to Manage Risks

Table 7-1 compares the International Frameworks and Typical Strategies that are adopted to reduce risks. To simplify matters, the Strategies for Reducing Risks have been split into three sections: ‘Structural’, ‘Non-Structural’ and ‘Risk Sharing’. Broadly, a structural measure is one that is a *tangible entity*, such as a flood protection measure, while a non-structural measure may describe an *approach*, such as legislation, a training course etc. However, such tidy divisions may not apply to certain strategies, such as an Early Warning System that will normally comprise structural elements, (such as buildings/ instrumentation/ communications) as well as non-structural measures (such as a community evacuation plan).

[INSERT TABLE 7-1 HERE:
Table 7-1: International frameworks and typical strategies to manage risks.]

7.3.3.2. Actors in the International Policy Frameworks

Table 7-2 lists typical actors who play key roles in Disaster Risk and Climate Change as well as within other International Frameworks.

[INSERT TABLE 7-2 HERE:
Table 7-2: International frameworks and typical actors who manage risks.]

7.3.4. Selected Other Relevant International Policy Frameworks and Agencies

The objectives of climate change adaptation and disaster risk reduction, outlined above are cross-cutting with a wider range of governance and institutional mandates. Similarly, both gradual climate change and extreme weather events, impact on, and are mediated by, other determinants of human vulnerability, such as levels and distribution of natural and economic resources, and the capacities of specific sectors.

It is important to recognize that actions taken outside of the specific DRM and CCA frameworks, for example to enhance economic growth or sustainable development, are likely to have at least as much of an influence on vulnerability to extreme events and the gradual effects of climate change. Rather than attempting an exhaustive review, this section describes the main international effort to promote international development (achievement of the Millennium Development Goals), and selected examples of more specific frameworks that are relevant to DRM and CCA.

7.3.4.1. Millennium Development Goals

Population and ecosystem vulnerability to weather extremes is strongly conditioned by socio-economic development, including income levels and distribution, and supportive institutional frameworks. In addition, 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).

In 2000 the Millennium Declaration identified a series of eight Millennium Development Goals (MDGs), which all members of the United Nations as well as 23 international organisations agreed to achieve by 2015. The eight MDGs break down into 21 quantifiable targets that are measured by 60 indicators.

- MDG 1: Eradicate extreme poverty and hunger
- MDG 2: Achieve universal primary education
- MDG 3: Promote gender equality and empower women
- MDG 4: Reduce child mortality
- MDG 5: Improve maternal health
- MDG 6: Combat HIV/AIDS, malaria and other diseases
- MDG 7: Ensure environmental sustainability
- MDG 8: Develop a Global Partnership for Development.

Sustainable development and progress towards attaining the MDGs are also important elements for integrating adaptation into national plans and programmes, as are risk management and risk reduction policies and poverty alleviation programmes. The target date of the Hyogo Framework for Action was synchronized with the intended completion of the Millennium Development Goals (MDGs) by 2015. The MDGs relate to disasters in two ways: First, if disasters occur they can set back general progress in achieving these goals. Second, the goals connect with specific aspects of disaster risk reduction and climate change adaptation in the manner shown in Table 7-3.

[INSERT TABLE 7-3 HERE:
Table 7-3: Linkages of MDGs to DRM and CCA.]

7.3.4.2. International Trade Frameworks

International trade frameworks affect overall economic development, including rates and equity of poverty alleviation, a key determinant of resilience and adaptive capacity. They also affect transfer of technologies necessary for DRM and CCA. The rules of trade between nations are mainly governed through the World Trade Organization (WTO), which produces accords governing trade in agriculture, services, industrial goods and other matters related to the global economy. The WTO is considering the challenges of climate change. In the Marrakesh Agreement establishing the World Trade Organization, members States established a clear link between sustainable development and disciplined trade liberalization in order to ensure that market opening goes hand in hand with environmental and social objectives. In the current round of negotiations, the Doha Round, members went further in their pledge to pursue a sustainable development path by launching the first multilateral trade and environment negotiations (WTO-UNEP, 2009). A number of aspects of the Doha Round have a direct bearing on sustainable development and can therefore contribute positively to efforts to adapt to climate change. The countries vulnerable to climate change, particularly the LDCs are reported to face constrains by the current international regime of technology transfer. Preferential access to technologies and know-how pertaining to adaptation has remained a crucial challenge for LDC countries to effectively deal with climate extremes (UNCTAD, 2009).

7.3.4.3. Global Health Frameworks

Global health frameworks can help to contain the international spread of diseases that can potentially result from extreme weather events. In response to the exponential increase in international travel and trade, and emergence and re-emergence of international disease threats and other health risks, 194 countries across the globe have agreed to implement the legally binding International Health Regulations (IHR, 2005). These aim to enhance national, regional and global public health security. Key milestones for countries include the assessment of their surveillance and response capacities by June 2009 and the development and implementation of plans of action to ensure that these core capacities are functioning by 2012. The stated purpose and scope of the IHR are "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade." Because the IHR are not limited to specific diseases, but are applicable to health risks, irrespective of their origin or source, they will follow the evolution of diseases and the factors affecting their emergence and transmission. The IHR also require States to strengthen core surveillance and response capacities at the primary, intermediate and national level, as well as at designated international ports, airports and ground crossings.

7.3.4.4. International Standards

International standards are defined for a range of practices and materials relevant to DRM. The International Organization for Standardization (ISO) is composed of representatives from various national standards organizations, and has the ability to set standards that are often incorporated into international law. Objectives include – to assist the environmental integrity of GHG assertions, assist organizations to manage GHG related opportunities and risks**.** International Standards practical tools for addressing climate change. ISO standards offer practical tools for addressing climate change at four levels.

1) Monitoring climate change (FAO/WMO)
2) Quantifying GHG emissions and communication on environmental impacts
3) Promoting good practice in environmental management and design
4) Opening world markets for energy efficient technologies.

While most of these tools relate to climate change in general and mitigation in particular, there are many aspects of ISO standards that are relevant to DRM and CCA. One of these is a new ISO 31000 standard on risk management. This strengthens the conceptual and methodological basis for managing human, environmental and economic risks from hazards, including providing a common language among multi-disciplinary actors and combining prevention, preparedness, response and recovery measures. ISO standards also address specific aspects of vulnerability to

extremes, particularly the range of ISO standards for insulation, thermal comfort and structural safety in buildings. They also cover specific hazards during disasters. For example, IWA 6, *Guidelines for the management of drinking water utilities under crisis condition*.

7.3.4.5. World Meteorological Organization

The WMO Disaster Risk Reduction Programme aims to ensure the optimization of its global infrastructure and the integration of its core scientific capabilities and expertise into all relevant phases of disaster risk management at the international, regional and national levels, particularly related to risk assessment and early warning systems. WMO and NMHSs have the capability to develop and deliver critical products and services to the entire disaster risk management decision process. These include the multidisciplinary science to understand the vulnerability of communities to weather-, climate- and water related hazards and hazards information for planning of emergency response and disaster mitigation/prevention. These systems operate alongside educational and capacity-building services that help ensure that nations can better meet national needs for hazard information. The DPM's strategic goals are being realized through an action plan implemented through national and regional projects involving WMO programmes, technical commissions, regional associations and partner organizations that assist member States in strengthening their capacities in disaster risk reduction.

7.3.4.6. The Red Cross and Red Crescent Code of Conduct

The Red Cross / Red Crescent Climate Centre is the reference centre on climate change of the Red Cross / Red Crescent family. The Climate Centre supports the Red Cross and Red Crescent movement 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.

In 1994, the *Code of Conduct in Disaster Relief* was developed by the Red Cross and Red Crescent. By 2010, 446 organisations had signed the code. The principle commitments by the Red Cross and Red Crescent Movement at the 2007 International Conference are as follows:

1) The Humanitarian imperative comes first.
2) Aid is given regardless of the race, creed or nationality of the recipients and without adverse distinction of any kind. Aid priorities are calculated on the basis of need alone.
3) Aid will not be used to further a particular political or religious standpoint.
4) We shall endeavour not to act as instruments of government foreign policy.
5) We shall respect culture and custom.
6) We shall attempt to build disaster response on local capacities.
7) Ways shall be found to involve programme beneficiaries in the management of relief aid.
8) Relief aid must strive to reduce future vulnerabilities to disaster as well as meeting basic needs.
9) We hold ourselves accountable to both those we seek to assist and those from whom we accept resources.
10) In our information, publicity and advertising activities, we shall recognise disaster victims as dignified human beings, not hopeless objects.

The urgency of addressing the humanitarian consequences of climate change is evident and actions to address these risks need to be ambitious. As reflected in the declaration "together for humanity" the movement has committed to:

- Raise awareness on climate change
- Provide humanitarian assistance
- Improve capacity to respond, including through better disaster preparedness
- Decrease vulnerability of communities most strongly affected
- Integrate climate risk management into policies and plans
- Mobilise human and financial resources, giving priority to actions for the most vulnerable people.

7.3.4.7. Global Facility for Disaster Reduction and Recovery 2006-2015

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a partnership of the International Strategy for Disaster Reduction (ISDR) system to support the implementation of the Hyogo Framework for Action (HFA). The GFDRR is managed by the World Bank on behalf of the participating donor partners and other partnering stakeholders. The GFDRR provides technical and financial assistance to high risk low- and middle-income countries to mainstream disaster reduction in national development strategies and plans to achieve the Millennium Development Goals (MDGs).

GFDRR works to foster and strengthen global and regional cooperation among low- and middle-income country governments, international financial institutions, UN agencies, research and academic institutions, intergovernmental organizations, civil society organizations, and the private sector to leverage country systems and programs in disaster reduction and recovery. It supports development of new tools, practical approaches and financing instruments for disaster reduction and recovery; fosters an enabling environment at the country level that can generate greater investment in disaster risk reduction practices within a sustainable legal, policy, financial and regulatory framework; facilitates knowledge sharing about reducing disaster risks and sustainable disaster recovery; and creates adaptive capacities for limiting the impact of climate change.

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 s. 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 obligation – 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 suffers from entering into force and from problems with 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). Indeed, international refugee law as codified in the 1951 Convention relating to the Statue of Refugees has been rejected in application to those who cross international borders due to climate-induced migration. 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 potential future opportunities 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. Expanded the interpretation and application of existing international law, and the introduction of new law for disaster response and climate change adaptation are both submitted as 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" has also been 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. Projected Costs of Climate-Induced Extreme Events

7.4.2.1. The Cost of Climate Change

Available literature that quantifies the global cost of all climate change induced extreme events is scant. The principal challenge in assigning a cost of climate change induced extreme events is of attribution and detection of both the occurrence of, and damage from extreme events as a result of climate change. Another challenge is ensuring that the damages from climate change induced extreme events are examined not on current populations and economies, but on how future scenarios will affect future economies and people. Damages depend critically upon what is in harms' way, not just on the frequency and intensity of the events themselves. For example, the increase in damages from tropical cyclones over the last century in the United States can largely be explained by the increase in capital and people in the path of tropical cyclones (Pielke et al 2008).

While still in its infancy, there have been some recent advances in the literature that attempt to isolate and disentangle the damage of climate change induced extreme events, while controlling for other factors that affect exposure and vulnerability. The literature on tropical cyclone damages is more advanced than for other extreme events. It should be noted however, quantifying impacts or physical damages is, at best, a weak proxy for the "expected cost" of climate change: damages are one measure of the costs of extreme events. But that is different from the measuring of the "costs of managing events", which would depend on the range and type of interventions, and for which there are no existing global estimates.

7.4.2.2. Expected Global Damage from Tropical Cyclones

Climate change could increase future damages from extreme events (IPCC 2007a; IPCC 2007b), with earlier studies estimating global annual damages from tropical cyclones of $630 million (Pearce et al, 1996). Recently, several published papers report an increase in tropical cyclone intensity over the last 30 years (Emanuel 2005, IPCC 2007a), and some reporting increases in tropical storm damages over time (Swiss Re, 2006). The link between climate change and tropical cyclone damage remains controversial, however. Partly this is due to the fact that tropical cyclones are rare events and so it is difficult to detect changes in underlying frequencies and severity (Landsea et al., 2006).

The most recent study to quantify the damage of climate change on tropical cyclones estimates future expected damages as a result of climate change by 2100 to be between $28 and $68 billion dollars (Mendelsohn et al, 2010). These estimates are highly sensitive to assumptions made, and it should be emphasized that substantial uncertainty accompanies these projections, and these projections measure just direct damages. The study also finds that climate change is expected to skew the damage distribution of tropical cyclones and is likely to cause rare - but very powerful tropical cyclones - to become more common and destructive.

7.4.2.3. Expected Global Damages from Other Extreme Events

The literature on expected global damages from other extreme events is scant. Studies use trend analysis to extrapolate hazard damages in the future, arguing that future damages from all extreme events would be between 0.5 to 1 percent of GWP by 2050 (Stern, 2007). However, there are serious flaws in these trend analyses because they confuse the effects of changes in income and population with changes caused by climate change (Pielke, 2007).

7.4.2.4. Summary

There is increasing evidence that climate change will amplify damages by affecting the frequency, intensity, and location of hazards. For many events, notably tropical cyclones, large and rare storms are expected to cause a high fraction of the total damages. All estimates presented above are uncertain, and levels of uncertainty prevail at all levels – from the science to how damages are calculated.

7.4.3. 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). Several international organisations have made calculations of the cost of adaptation in developing countries, albeit based on rough assumptions and inconsistent timelines (shown in Table 7-4).

[INSERT TABLE 7-4 HERE:
Table 7-4: Annual adaptation costs in developing countries.]

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 (Michell et al 2008).

The GEF manages the Least Developed Country Fund (LDCF), the Special Climate Change Fund and the Strategic Priority on Adaptation (SPA). There have been concerns 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 (Michell 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 can 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. 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 (COP-15, 2009), 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).

7.4.4. Technology Transfer/Cooperation

7.4.4.1. 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. 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 adaptation technologies 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 adaptation technologies 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 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. For a comprehensive discussion of these issues see 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 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. In addition 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).

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 7-1). Some other types of technologies are more recent, involving advanced materials science, perhaps, or remote satellite sensing. The report provides an overview of the old and the new technologies available in adapting to changing environments, including climate change.

_____ START BOX 7-1 HERE _____

Box 7-1. Examples of Adaptation Technologies 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 appropriate models. 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).

_____ END BOX 7-1 HERE _____

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). Institutions vary widely across scales (small to large, local to national), sectors (such as agriculture, water, forestry, transport) and from formal (*e.g.*, Ministry or Department of Environment, NAPA Secretariat) to informal (*e.g.*, a local village community). Whilst formal institutions can respond to adaptation needs and challenges with regulations, institutional guidelines and allocated resources, informal institutions often respond to specific adaptation challenges such as drought, flood or a cyclone as self-organised and self-motivated systems. In between these two extremes there is a range of institutional arrangements and 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).

7.4.4.2. 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).

UNFCCC (2005) contains a summary of the 20 presentations delivered at the seminar on the development and transfer of environmentally sound technologies for adaptation to climate change from 14–16 June 2005, in Tobago, Trinidad and Tobago. The report includes summaries of presentations regarding such issues as needs for, the identification and evaluation of technologies for adaptation to climate change, and financing their transfer. Several participants from developing countries highlighted the need to focus on the means to transfer technology and that cost is one of the highest barriers in technology transfer. Daniele Violetti (UNFCCC Secretariat) presented options for innovative financing for the development and transfer of technology together with a list of potential funding for technology transfer, including 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. The GEF funds for adaptation activities include four programmes: the Strategic Priority on Adaptation (SPA) trust fund; the LDC Fund; the SCCF; and the Adaptation Fund under the Kyoto Protocol. 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 is developing a screening tool to help the user find out what climate vulnerabilities should be addressed in a specific project (UNFCCC, 2005). Both conventional and innovative options for financing the transfer of adaptation technologies might be explored. As conventional options the GEF funds (SPA, LDC Fund, SCCF and Adaptation Fund) 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).

7.4.4.3. 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 covered in the report:

- 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 permit a fundamental 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. It is important to note that, to the extent it is possible, such 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 components. The use of GIS in the support of emergency operations in the case of both weather 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.

Space technologies (such as Earth observation, satellite imagery, real time application of space sensors, mapping) are important in the reduction of disasters (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. Among others issues, Rukieh and Koudmani (2006) also review the importance of space technologies for such extreme weather events as drought, flood, storms, and ice-hazards.

Support for relief agencies and governments depend 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 recent developments in a study to provide 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. 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 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 HIMAWARI (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. 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.

Groat (2004) address a major challenge in natural hazards research 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. The issue of tracking floods is taken as an example. The most common method for measuring open-channel flow has remained unchanged for more than 100 years. A technician is suspended over a river in a cable car or stands on a bridge while lowering a propeller- type current meter into the fast-flowing water to calibrate the changing relationship between river stage and discharge. The method can be hazardous, especially during floods when information on flow velocity is most needed. Recently, two advances have contributed to improved speed and accuracy of making direct stream flow measurements. First, acoustic Doppler current profilers (ADCPs), attached to a moving boat, send acoustic energy into the river and reflect from particulate matter suspended in the water. The second advance in protecting lives from flood hazards results from the capability to predict the timing, locations, and severity of forecasted floods. By combining detailed digital elevation models (produced by high-resolution LIDAR mapping from low-flying airplanes) with a robust, efficient, two-dimensional flow model, the extent of a predicted flood can be mapped a few days to a week before the flood begins.

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.

7.4.5. Risk Transfer, Risk Sharing

7.4.5.1. Introduction

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 for individuals Governments of vulnerable countries that do not wish to rely on ad hoc and often insufficient post-disaster assistance. The international community can play a role in enabling individual, national and international risk transfer strategies, and this discussion identifies successful practices, or value added, as well as constraints on this role.

7.4.5.2. International Risk Sharing and Transfer

The Bali Action Plan calls for 'consideration of risk sharing and transfer mechanisms, such as insurance' as a means to address loss in developing countries that are particularly vulnerable to climate change (Decision 1/CP.13, Bali Action Plan). Similarly the Hyogo Protocol calls on the disaster community "to promote the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters" (ISDR, 2005a: 11).

Risk transfer and risk sharing are pre-disaster financing arrangements that shift economic risk from one party to another. These arrangements, which include informal instruments (e.g. remittances) and formal market instruments (e.g., insurance), can be an essential part of an overall adaptation strategy. They do not reduce overall risk or losses, and in the case of insurance they increase the expected average loss; yet, by smoothing consumption, financial instruments protect against catastrophic losses and by supplying timely capital for recovery, they reduce long-term indirect disaster impacts. They also provide the security necessary for productive investments, thus promoting development and helping the most vulnerable escape disaster-related poverty traps (Barnett et al., 2008). At the same time, poorly designed instruments can lead to disincentives for reducing disaster risks (moral hazard), and public and international interventions can crowd out private sector operations and investments. These drawbacks should be viewed in relation to the alternative of international post-disaster aid, which, in theory, reduces incentives for and expenditures on ex-ante prevention (Raschky and Weck-Hannemann, 2007; Linnerooth-Bayer, et al., 2005).

Often by necessity risk transfer is international. Local and national pools (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 arrangements for sharing and transferring 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, ISDR (2005) and 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. This section briefly describes the range of financial instruments available for sharing and transferring the risks of extreme climate-related events, and concludes with a discussion of the value added by international organizations.

7.4.5.3. Informal Risk Sharing through Remittances

Reciprocal arrangements, including inter-household transfers, spread risks spatially and might be considered a precursor of formal market pooling or insurance arrangements. Quantifying the prevalence of inter-household transfers is, owing to its informal and multi-definitional nature, inherently difficult. Yet combined analysis of multiple surveys indicates that about 40 per cent of developing country households are involved in private transfers in a given year, either as recipients or donors, or both (Cox and Fafchamps, 2007). Local informal risk sharing is inherently restricted by limited resources and diversification opportunities.

Remittances, transfers of money from foreign workers or ex-pat communities to their home countries, make up a large part of these informal transfers, even exceeding official development assistance. In 2006, the official worldwide flow of remittances is estimated at $268 million, and unrecorded flows through informal channels 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; Sanket et al., 2009). Payments can be sent through formal, standard means such as banks or professional money transfer organizations, but often these channels break down and remittances are carried by hand (Savage and Harvey (2007). While remittances are simple in concept, their use 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 widely between 2.5% and 40% (DFID, 2005). Information pertinent to the transfer is often obscure or in a language unfamiliar to the worker sending funds, and as such, they do not have access to all possible options. Remittance transfers have been complicated across some borders due to initiatives taken by developed nations to counter international money laundering and financing of terrorism (Fagen and Bump, 2007). Finally, a major problem facing post-disaster victims is difficulties in communicating with relatives abroad, and the subsequent inability to request aid, 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.

7.4.5.4. Post-Disaster Credit

As one of the most important post-disaster financing mechanisms, credit provides governments, individuals and households with resources after a disaster, but with an obligation to repay these resources 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 emergency recovery and reconstruction purposes for 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).As a recent innovation, international organizations are making 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 since increased demand can challenge the liquidity of credit organizations and tempt relaxed loan conditions or even debt pardoning. This risk is particularly acute in vulnerable regions. A risk transfer instrument can help MFIs remain solvent in the post-disaster period. Recognizing this, 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). Located in Costa Rico, ELF provides needed and immediate post-disaster liquidity at break-even rates to MFIs across the region. Low-interest credit enables MFIs to continue extending affordable credit in time of crisis. Of equal importance, ELF provides fledgling MFIs with technical know-how to make their operations disaster proof.

7.4.5.5. 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 primary and reinsurance markets attracting capital from international investors, insurance

has become an instrument for transferring disaster risks over the globe. This market is highly international in character. For example, in the period 2000-2005 U.S. insurers purchased reinsurance annually from more than 2,000 different non-U.S re-insurers (Cummins and Mahul, 2009: 115)

World-wide insurance for climate-related losses is unevenly distributed. From 1980 through 2003 insurance covered 4 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 has played a formidable and essential role in many recent micro- and sovereign (macro) insurance initiatives as a few examples (discussed in Chapters 5 and 6) illustrate:

- 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 considerable challenges to scaling up current operations. Lack of data, regulation, trust and knowledge about insurance are some of the barriers (Hellmuth, 2009; Miamidian, 2005).

Insurance and other risk financing instruments are particularly effective when used in conjunction with 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).

7.4.5.6. 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 catastrophe 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. Insurers and reinsurers in developed countries account for over 95% of cat bonds by issue volume. Although it is still an experimental market, the annual stream of 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 defray costs of disaster recovery and relief. The World Bank provided technical assistance for these transactions. The first bond transferred $160 million

of Mexican earthquake risk to the international capital markets through a special-purpose vehicle. Although the transaction costs of this placement were large, and basis risk and counterparty credit risk are impediments to the success of these contracts, 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 governments are vulnerable to catastrophic risks, and post-disaster financing strategies generally have high opportunity costs for developing countries

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 inter alia the important role that securitized instruments/insurance can play in assuring the financial wherewithal for humanitarian aid when disasters strike.

7.4.5.7. International Risk Pools

Catastrophe insurance pools are a promising innovation that enables highly vulnerable countries, and especially small states, to more affordably transfer their risks. By pooling risks across individual countries, regions and the world, catastrophe insurance pools generate diversification benefits that are reflected in reduced insurance premiums. In addition, by accumulating reserves over time, pools are able to increase risk retention, thereby allowing further reduction in insurance premiums. Finally, there is growing empirical evidence that catastrophe insurance pools have been able to diversify inter-temporally to dampen the volatility of the reinsurance pricing cycle and offer stable premiums to the insured countries. (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 depending on the exposure of their specific country 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 overcome 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.

7.4.5.8. 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
- *Supporting public goods* for development of risk market infrastructure, for example, donors could fund 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, and the World Bank provided technical assistance for the Mexican CAT bond
- *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
- *Financing risk transfer*, as examples, the Bill Gates Foundation subsidizes micro-insurance in Ethiopia; the World Bank provides low-cost capital backing for the Mongolian micro-insurance program; Swiss SECO and IDB provide low-interest credit to the ELF, and many countries have contributed to the CCRIF fund.

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 7.2.2 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 7.2.4) 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.

Recognizing these concerns, most commentators agree that there are important and valid reasons for interfering in catastrophe insurance and other risk-financing markets in specified contexts (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.

7.4.5.9. Proposals for Insurance as Part of an Adaptation Strategy

Recognizing that insurance is not appropriate in all contexts, and that it must be viewed as only a part of a comprehensive risk-management program, two proposals for including insurance in an adaptation regime have recently been put forward. The Munich Climate Insurance Initiative (MCII) proposes a two-pillar Risk Management Module as part of an adaptation regime (MCII, 2008), and almost identically, the Alliance of Small Island States (AOSIS) proposes a three-component Multi-Window Mechanism (AOSIS, 2008). Both include provisions for supporting preventive measures and for enabling micro- and national insurance systems (as well as regional pools) in vulnerable developing countries by providing technical assistance, capacity building and possibly absorbing a portion of the insurance costs. Both proposals also have important elements not shared by the other. MCII suggests a Climate Insurance Pool that indemnifies victims of extreme catastrophes in vulnerable countries by a percentage of their losses, where premiums are paid fully by an adaptation funding mechanism. AOSIS suggests a rehabilitation/compensatory component that would compensate victims for sea-level rise and other uninsurable damages.

7.4.6. Knowledge Creation, Management, and Dissemination

The growing concern on increasing incidents of disasters globally has put great pressure on the need for knowledge generation, management and dissemination in the field of disaster risk management. The various DRR measures noted above, e.g. risk transfer, technology development and transfer, legal aspect and so forth will be of use where they are known and fully understood to the extent that they can be assimilated in DRR at all scales. An internationally agreed mechanism for generation, storage and retrieval and sharing of integrated climate change risk information, knowledge and experiences is yet to be established (Sobel and Leeson, 2007). Where knowledge

generation, sharing and dissemination is 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 actors at different levels to different options available for reducing climate risks. Such a mechanism will support efforts to mainstream disaster management 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).

Attempts have been made to improve information sharing and dissemination for disaster relief. UNOCHA established the ReliefWeb (http://www.reliefweb.int) in 1996 to act as a clearinghouse for humanitarian information and has since 2002 organised four gatherings on humanitarian information management and exchange for various disasters (Wolz and Park, 2006; Maitland and Tapia 2007; Saab et al., 2008).

7.4.6.1. Knowledge Organization, Sharing, and Dissemination

International climate change risk management requires integration of different types of information, knowledge and experiences and their effective dissemination for use in determining levels of exposure and vulnerabilities across temporal and geographical scales to establish appropriate action (Louhisuo et al., 2007; Kaklauskas et al., 2009). The need for a global strategy to effectively amalgamate and share existing knowledge across scales was noted by Marincioni, 2007. For example, 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. In disaster relief, comprehensive and authoritative information facilitate appropriate response and recovery measures to be implemented (Zhang et al., 2002). 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 vary across scale i.e. from the local level where participatory approaches are used to incorporate indigenous or local knowledge and build collective ownership of knowledge generated; to the broader regional to international levels thus providing for the application of the principle of subsidiarity in the organisation, sharing and dissemination of disaster risk management (Chagutah, 2009).

In recognition of geographical differences and various levels of needs for humanitarian information, UNOCHA held a Global Symposium on humanitarian information management in Geneva 2002 which was followed by three similar regional humanitarian information network workshops in Bangkok, Panama, and Nairobi between 2003 and 2006 (Maitland and Tapia 2007; Saab et al., 2008). Exchange of disaster information worldwide has increased tremendously through for example, mass media and Information and Communication Technologies (ICT). In a disaster situation survival and recovery are closely linked to provision of effective communication prior to and throughout the disaster situation (Paul, 2001). 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 (Vasterman et al., 2005). Further the media do not operate in a social vacuum and as a result 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 (Chagutah, 2009; Kaklauskas et al., 2009).

Increased use of information communication technology (ICT) such as mobile phones, online blogging and real time crowd-souring electronic commentary and other forms of social networked communications such as Twitter, Facebook etc. all represent current tools for timely delivery of disaster information to people who need it, that is if the information is given in an appropriate format, and language. There are emerging attempts to develop mobile phone based disaster response services such as systems 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**).** The UN OCHA ReliefWeb site for humanitarian so far offer the largest internet based international disaster information gathering, sharing and dissemination although there are other initiatives such as the NetHope International which combines development and disaster issues into its IT-centric mandate (Saab et al. 2008) and services that augments the RelifWeb such as the International Charter which provides space data (http://www.disasterscharter.org).

While the use of mobile phones and Internet facilities have fast penetrated different parts of the world including developing countries their potential in disaster relief is not yet fully exploited. For disaster relief, the UN OCHA ReleifWeb poorly represents local to national level humanitarian activities (Wolz and Park, 2006) and does not cover preparedness and disaster prevention. 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). 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 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 provides for the filtering of tacit knowledge, therefore 'best practices' across regions.

Nevertheless as with humanitarian needs, the use of information technologies (IT) e.g. computer networks, digital libraries, satellite communications, remote sensing, grid technology, Geographic Information Systems (GIS), for disaster risk reduction has also significantly increased data and information exchange on risks (UN ISDR, 2005b; Louhisuo et al., 2007). IT offers interactive modes of learning which could be of value in distance education and online data sharing and retrieval 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 mass of disasters in the world from 1900 to present. This data is useful for disaster preparedness, and vulnerability assessments (CRED, 2006). In addition 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 is an important contribution of IT capabilities in disaster risk reduction (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).

The emergence of a facility such as the PreventionWeb (www.preventionweb.net/) under the UN ISDR in 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 with the purpose of becoming a single entry point to the full range of global disaster risk reduction activities and hence provides a common platform for institutions to connect, exchange experiences and share information on DRR. This is similar to the case of reliefweb described above for humanitarian needs. 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 and hence while it caters 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.

However, in all the 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. There are differences in perception on the role of IT in 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). Others conclude that while there is increased circulation of disaster information this does 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; 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). As a result the contribution of facilities such as PreventionWeb will among others depend on accessibility and assimilation of IT in daily operations of institutions across the globe. Others note further 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 (Chagutah, 2009).

In addition, one major constrain in climate change risk management is that for sometime communities working in disaster management, climate change and development have operated separately even though they are all concerned with human wellbeing. 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 use of insurance but fail to link this to climate risk reduction. Similar observations have been made on cities where urban developers have no link with climate risk management community (Wamsler, 2006). Linkages among these communities through coordinated knowledge sharing are an important part of global security (Schipper and Pelling, 2006).

Communication gaps between professional groups often results from different language styles and jargons. Heltberg, (2008) has 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 a factor also noted by others e.g. for better coordination among numerous humanitarian organization (Saab etal., 2008) and the FAO guide for disaster risk management (Baas et al., 2008). 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).

7.4.6.2. Knowledge Generation

Integrated risk management requires skilful use of different types of knowledge (scientific, social sciences, traditional knowledge, etc) (Heltberg, 2008). Such knowledge needs to be generated, documented and evaluated for its authenticity and applicability over time and beyond its point of origin (Rautela, 2005). Knowledge generation has to focus on the initiated shift in emphasis by HFA from reactive emergency relief to pro-active disaster risk reduction to strengthen prevention, mitigation and preparedness. 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 disaster risk reduction approach (Köhler and Wächter, 2006). There are huge efforts in knowledge generation and exchange by universities, government agencies, international organizations and the private sector but coordination of these efforts internationally is yet to be achieved (Marincioni, 2007).

The generation of climate change information has followed a top down approach by using 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 (Weingart et al., 2000;Schipper and Pelling, 2006). 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. 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. In general locally relevant climate change risk information is lacking and the capacity to generate such information is inadequate a factor contributing to vulnerability.

Knowledge generation requires capacity in terms of skilled manpower, infrastructure and appropriate institutions and funding. 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 are not adequately equipped. 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 (Carvalho, 2007).

Interdisciplinary knowledge generation i.e. bridging the traditional divide among the social, natural, behavioural, and engineering sciences continues to be a great intellectual challenge in risk reduction. For e.g. despite the value of IT in information retrieved through the Internet, such information is rarely cross disciplines to provide building of balanced knowledge on risk management (Marincioni, 2007).

In conclusion literature shows that data and information on their own are not a complete solution to risk reduction. Resources to supply information in a usable form for each unique case so as to translate this to knowledge and action are a critical dimension in risk reduction. Sharing experiences is also important. 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. Great effort has been put on data, information and knowledge generation and management for disaster relief but this is now changing to incorporate risk management although this is at a rudimentary stage.

7.5. Consideration for Future Policy and Research

7.5.1. Parallel Paths: Disaster Risk Reduction and Climate Change Adaptation

Disaster risk reduction/management and climate change adaptation have common objectives (building resilience) and potential for shared benefits (decreasing future risk and vulnerability) despite having long existed on different policy and research platforms and agendas (Davies, et al., 2008). The adoption of the 1990s as the International Decade for Natural Disaster Reduction can be considered as the first concrete step made by the international community towards the creation of substantial programmes to mobilise efforts at the international level for reducing disaster risks and vulnerabilities. While the release of the IPCCs Third Assessment Report in 2001, containing the chapter, “Adaptation to Climate Change in the Context of Sustainable Development and Equity”, similarly, can be marked as one of the dominant steps pushing adaptation forward in the spotlight with the Marrakesh Accord during COP-7 in 2002 further lifting adaptation issues in the development agenda and strengthening the adaptation profile. Since then, CCA and DRR have separately been gaining ground within the development discourse. Historically, climate change was viewed as an environmental pollution issue with international agreements narrowly focused on mitigation, while neglecting other responses including adaptation (Burton et al. 2007). This misconception of CCA also separated it from its similarities to DRR. Disasters and risk reduction is now included in the Bali Action Plan (BAP) text - Decision 1/CP.13 (from BAP) states that, “Enhanced action on adaptation, including inter alia, consideration of: risk management and risk reduction strategies, including risk sharing and transfer mechanisms such as insurance; (iii) Disaster reduction strategies and means to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change.” Both DRR and CCA are now being viewed in the context of sustainable development with one of the strategic goals of the HFA being the strengthening of the “integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness, and vulnerability reduction”. Similarly, the UNFCCC includes the need of “...implementation of adaptation actions on the basis of sustainable development policies”.

While the knowledge on DRM has advanced considerably, the progress remains behind the level that is required to deal with the increasing challenge of disaster and climate risks and extremes. Some promising efforts have been made through NAPAs in LDCs and Nairobi Work Programme, as well as actions by multilateral and bilateral agencies (Ref ??). However, advancement of CCA awaits further acceleration under a proactive international regime

supported by consensus and agreement among developed and developing countries..There has also been some successful piloting on adaptation at the local regional and in some cases at the national level (see Chapter 6) but these are yet to form a critical mass for up-scaling at the international level. While there is available knowledge on adaptation to climate extremes in some quarters its application is still very limited. As highlighted in the Global Assessment Report by UN ISDR, the adaptation agenda lacks organisational leadership at all level. This problem is rooted in the lack of consensus and concrete guidance from the international communities, confusion and differing views among professionals and decision makers first on what adaptation is as opposed to development is and on what it means to integrate DRR-CCA into development.

7.5.2. Synergies and Integration of DRR and CCA

Recently, synergies are being increasingly identified between DRR and CCA (O'Brien, et al., 2006; Thomalla et al., 2006). This trend is likely to continue, resulting in DRR and CCA to be more commonly found on the same research and policy platforms. While hazards classified under DRR and CCA differ, the overlap between climatic hazards is strong – both consider other hazards and impacts (DRR including seismic activity and CCA including biodiversity and desertification). ISDR stated that governments have recognized the importance of coordinating their climate change adaptation plans with disaster risk reduction measures. They also recognize that these policies should be incorporated into their development and poverty eradication programmes (UN ISDR, 2008). With that, ISDR secretariat stated they support these efforts in three areas: Achieving recognition, understanding and the development of specific policies at the international level on the synergies between reducing disaster risk and responding to climate change; Mobilizing, guiding and facilitating action at national and regional levels to integrate disaster reduction and climate change policies and practice; and Strengthening the capacities of the ISDR system to support the integration of disaster reduction and climate change by all actors (UN ISDR, 2008). The capacity for DRR and CCA are highly dependent upon an acceleration of international efforts to reduce greenhouse gas emission. If such an effort is absent or delayed then the tasks of DRR and CAA will become significantly greater and there is a danger in some sectors of exceeding the limits of adaptation (Adger, 2009). Nevertheless much can be achieved by adaptation, although this has yet to be tested and the past record of adaptation to extreme climate-related events is not so encouraging. Losses have continued to rise (Haque and Burton, 2005). The evidence suggests that DRR and CCA could be made more effective by strengthening the capacities and local governments to integrated DRR and CAA into a broader management strategy to ensure availability of safe low risk land for development, more secure land tenure, infrastructure and services and adequate disaster resistant housing especially for the urban poor. Additional investment in natural resource management, ecosystem services, infrastructure development and livelihood generation and strengthening could help to reduce vulnerability and strengthen the resilience of rural areas. A stronger shift from post-disaster relief and reconstruction towards pre-event adaptation could lower the impacts of climate extremes (Helmer, and Hilhorst, 2006; Thomalla et al., 2006).

7.5.3. Opportunities for Future DRM/CCA Policy and Research

Climate change exacerbates existing disaster and extreme event risk – threatening the stability of already vulnerable communities. And while some of the hazards differ for DRR and CCA, opportunities for closer collaboration exist in both communities. CCA can learn from past DRR experience and local on the ground knowledge, and DRR can learn from CCA community's scientific knowledge. The exchange of information between the DRR and CCA community along with knowledge of past and potential future events can benefit both. This trend is increasing in the literature (Schipper, L. and M. Pelling, 2006; Subbiah, 2008) and within plans and policies in governments at all levels (; Hilhorst, 2003). Commonly, government and institutional departments are separate for CCA and DRR. Research and policy may benefit from closer collaboration - potential opportunities to jointly reduce risk, learn from experience and share knowledge. This opportunity could increase the ability to adapt to climate change and to reduce disaster risk at all levels (van Aalst et al., 2008). DRR commonly works at local and regional levels; adaptation can be advanced by this experience (Vatsa, 2004). There is also the potential to include DRR in CCA policy and research, CCA in DRR policy and research or the creation of new joint policy and research with the explicit agenda of incorporating both (Velasquez, 2008; Wilson and Mcdaniels, 2007). Technology transfer under

the UNFCCC – "Increasing options for sharing and mitigating risks and for bundling small-scale projects to bridge the distance between large-scale infrastructure investors and small-scale project and business developers".

According to ISDR, DRR and CCA share the same ultimate goal of reducing vulnerability to weather and climate hazards. HFA calls on countries to integrate risk reduction measures and climate change adaptation through the following Priorities for Action: 1. Good governance, planning, budgeting and implementing policies to avoid settlement in hazardous areas and ensure that hospitals, schools, and transportation are hazard resistant. 2. Understand the risks we face and take action based on that knowledge. We need to use risk knowledge to develop effective early warning systems. 3. Raise awareness and educate young and old alike so they can reduce their own vulnerability. Many countries are taking such steps through the media and in schools. 4. Changing practices and conditions that aggravate risk, such as environmental degradation and poverty. Protecting precious ecosystems, such as coral reefs and mangrove forests, allows them to act as natural storm barriers. Effective insurance and micro-finance initiatives can help to transfer risks and provide additional resources. 5. Prepare for the disasters that will inevitably strike by having contingency plans in place and emergency funds established, as well as regularly conducting simulation exercises. (UN ISDR 2005a)

Both DRR and CCA have an opportunity to address the underlying risks drivers that increases vulnerability to disaster and extreme events (rural livelihoods, poor urban governance and declining ecosystems that shape the relationship between disaster risk and poverty (Sabates-Wheeler, R. et al., 2008; Few R et al., 2006; UN ISDR, 2009a). A failure to address the underlying risk drivers will result in dramatic increases in disaster risk and associated poverty outcomes. In contrast, if addressing these drivers is given priority, risk can be reduced, human development protected and adaptation to climate change facilitated. Rather than a cost, this should be seen as an investment in building a more secure, stable, sustainable and equitable future.

The inclusion of disasters and risk reduction in the BAP and potentially as a component of the future agreements, lead to an opportunity for the inclusion of CCA in a post-2015, post-HFA, DRR agreement.

7.5.4. Other Relevant Issues and Capacities

7.5.4.1. International Humanitarian Response System

A review of the list of ISDR partner institutions reveals that humanitarian institutions are rapidly growing in numbers at international, national and local levels, often with overlapping mandates and coordination gap among them. It is therefore important to examine how international humanitarian system works in a situation of large and complex emergency which is a likely consequence of climate extremes.

The humanitarian reform system was evolved during 1990s that has stood the test of the time in saving lives and mitigating sufferings during each of the major catastrophic events. The humanitarian response system has coped with these major events and each of these major crises has in its own way tested the humanitarian response system; they have challenged perceptions of humanitarian assistance as impartial, they have challenged the appropriateness of response options and they have challenged the capacity of international and national actors to respond.

Strengthening the capacity of the humanitarian response system at the international and national level is the main reason for humanitarian reform by United Nations in 2006. There are three main elements to the humanitarian reform: 1) to create more predictable humanitarian finances to ensure and enable a prompt response to new or rapidly deteriorating crises; 2) to strengthen response capacity by establishing a system of cluster leads in those areas of activity where there are clearly identified gaps, and finally, 3) to strengthen the Humanitarian Coordinator system to better support field coordination.

7.5.4.2. Relocation or Migration

An extreme form of adaptation is relocation or migration. Relocation calls for a long-term planning and programming at the regional, national and international levels that aims to safeguard the vulnerable people by removing or decreasing their exposure to hazards. For small island states and densely populated low-lying countries like Bangladesh, relocation would eventually lead to a process where people will be obliged to move internationally. movement. Migration adds a fresh perspective to national land-use planning, zoning and relocation plan. A participatory process involving and engaging vulnerable nations is critically important for creation of an effective mechanism to international response.

7.6. Integration Across Scales

At the international level considerable efforts have been made since 1980's to move towards integrated disaster risk reduction. The Hyogo Framework for Action addresses disaster risk reduction with a clear indication of the need to consider climate change related risks (UN ISDR, 2009b). The ultimate objective of the UNFCCC is 'prevention of dangerous human interference with the climate system ' and this matches with both sustainable development and disaster risk reduction perspectives. Further the Bali Action Plan under UNFCCC emphasized the need to link adaptation with DRR. Another major internationally driven policy development is the Millennium Development Goals which are linked to development and poverty reduction and recognize the need for strong linkages with measures that address vulnerability to disasters. However, the international legal status of the UNFCCC, the HFA and the MDGs are not identical.

These three main policy frameworks continue to operate parallel to each other resulting in uncoordinated actions and duplication (Yamin et al., 2005; O'Brien et al., 2006; Thomalla et al., 2006). There are powerful legal, institutional and political obstacles that make it difficult for e.g. for disaster relief to be more development orientated or for it to shift from a reactive approach to disaster as opposed to a disaster risk reduction framework. For example, many decision makers respond more to actual disasters than to the need for DRR (Pelling 2006).

Addressing vulnerabilities has been in the hands of an array of national, regional and international institutions often with weak or no legal mandates and without an authoritative position either to command nor easily to achieve major changes for creating a resilient society. For example in practice, during reconstruction periods, after a disaster, few of the main actors make a deliberate effort to consider MDGs (Schipper and Pelling, 2006). Cases where development contributes to vulnerability e.g. – through carbon-intensive developmental pathways and through a variety of socio-economic and political actions are numerous and account for the currently observed climate change and partly to the failure to meet the MDGs (Pelling, 2006).

Some experts point to the need to devise a joint overarching objective that can synthesize both the concerns and interests of vulnerability reduction, for climate change, development and disaster relief communities, and through the respective policies which they ean espouse.. This will reinforce their individual efforts, while also multiplying, their combined contributions, achieving more effective use of resources in the process (Schipper and Pelling, 2006).

Covariate and potentially very large and irreversible risks associated with climate change imply a need for integration of policies across scale and which they require a higher level of international collaboration to a scale not yet achieved. To fully address climate related disaster risks, international cooperation may well need to extend to wider considerations such as labour matters and resulting migration flows or trade and economic policies. Additional consequences also would be manifested in food and financial markets, insurance calculations, peace-keeping and technology and in the array of research and development possibilities.

In 2001, the IPCC was able to conclude "Climate change does not in itself stimulate development of new DRR or CCA strategies but it encourages a more adaptive, incremental, risk-based approach to both the reduction of disaster risk and adaptation to climate change. More precisely, it provides further encouragement for a trend that is already gathering pace"(IPCC. TAR. WG II p. 227 2001). Since that time DRM and CCA have clearly gained in momentum but arguably as shown in this chapter fall short of demonstrated and acknowledged needs.

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Table 7-1: International frameworks and typical strategies to manage risks.

INTERNATIONAL FRAMEWORKS AND TYPICAL *STRATEGIES* TO MANAGE RISKS			
Strategies for Reducing Risks	**International Frameworks**		
	Disaster Risk Management (DRM) including the Hyogo Framework for Action (HFA)	**United Nations Convention for Climate Change (UNFCCC)**	**Other International Frameworks**
Through Non-Structural Measures	• *The Integration of DRR into sustainable development policies and planning.* ***(HFA Strategic Goal)*** • *The development and strengthening of institutions, mechanisms and capacities to build resilience to hazards.* ***(HFA Strategic Goal)*** • *Ensure that disaster risk reduction (DRR) is a national and local priority with a strong institutional basis for implementation* ***(HFA Priority for Action)*** • *DRR institutional mechanisms(national platforms) designated responsibilities* ***(HFA Key Activity)*** • *Use knowledge, innovation and education to build a culture of safety and resilience at all levels* ***(HFA Priority for Action)*** • *Networks across disciplines and regions; dialogue* ***(HFA Key Activity)*** • *Mobilise resources and capabilities of relevant national, regional and international bodies, including the UN System* ***(HFA Resource Mobilisation: States, Regional and International Organisations)*** • *Provide and support the implementation of the HFA in disaster prone developing countries, including through financial and technical assistance, addressing debt sustainability, technology transfer, public-private partnership and North-South and South-South cooperation* ***(HFA Resource Mobilisation: States, Regional and International Organisations)*** • *MainstreamDRR measures into multilateral and bilateral development assistance programmes* ***(HFA Resource Mobilisation:***	[To be completed]	• *UN Agencies supporting the Millennium Development Goals (MDG)* • *The United Nations Development Assistance Framework* • *International International Organisations promoting ISO Standards* • *World Trade Organisation (WTO)* • *WHO and other International Health Organisations who promote International Health Regulations* • *International Humanitarian, Rights organisations who promote Internation Human Rights and Refugee Law* • *The Red Cross Code of Conduct* • *International support for the Mauritius Strategy for the Sustainable Development of Small Island Developing States*

	States, Regional and International Organisations)		
Through Structural Measures	• *The systematic incorporation of risk reduction approaches into the implementation of emergency preparedness, response and recovery programmes.* ***(HFA Strategic Goal)*** • *Identify, assess and monitor disaster risks and enhance early warning.* ***(HFA Priority for Action)*** • *Early warning: people centred; information systems; public policy* ***(HFA Key Activity)*** • *Scientific and technological development; data sharing, space based earth observation, climate modeling and forecasting ; early warning* ***(HFA Key Activity)*** • *Regional and emerging risks (HFA Key Activity)* • *Sustainable ecosystems and environmental management* ***(HFA Key Activity)*** • *Regional approaches to disaster response, with risk reduction focus* ***(HFA Key Activity)***	[To be completed]	• *UN Agencies supporting the Millennium Development Goals (MDG)* • *The United Nations Development Assistance Framework* • *International Organisations promoting ISO Standards* • *International support for the Mauritius Strategy for the Sustainable Development of Small Island Developing States* • *The Red Cross Code of Conduct*
Through Risks Sharing/ Transfer	• *Develop partnerships to implement schemes that share, pool and transfer risks; improve affordability and accessibility of these schemes to the most vulnerable* • *Promote an environment that encourages a culture of insurance in developing countries* ***(HFA Resource Mobilisation: States, Regional and International Organisations)*** • *Financial risk-sharing mechanisms (HFA Key Activity)*	[To be completed]	***Diarmid Can you, (with some creative imagination!) relate any of these frameworks to risk transfer strategies?***
Notes: 1. Due to the large number of actors involved in international risk management/ risk reduction, collective descriptions are noted in this table, rather than attempting to list individual organizations 2. The strategies noted on this table are all those that require international, rather than merely national action. These strategies are undertaken by international actors working in partnerships with national governments and institutions			

Table 7-2: International frameworks and typical actors who manage risks.

INTERNATIONAL FRAMEWORKS AND TYPICAL *ACTORS* WHO MANAGE RISKS			
Actors who Manage Risks	**International Frameworks**		
	Disaster Risk Management (DRM) including the Hyogo Framework for Action (HFA)	**United Nations Convention for Climate Change (UNFCCC)**	**Other International Frameworks**
Through Non-Structural Measures	• *Governments* • *Regional Intergovernmental Organisations* • *UN System* • *Other International Organisations* • *International Financial Institutions (IFI's)* • *Non-Governmental Organisations* • *Private Sector* • *Media* • *Academic Institutions*	***[to be completed]***	• *UN Agencies (supporting the Millennium Development Goals) (MDG)* • *The United Nations Development Assistance Framework* • *International Organisations (promoting ISO Standards)* • *World Trade Organisation (WTO)* • *WHO and other International Health Organisations (who promote International Health Regulations)* • *International Humanitarian, Rights organisations (who promote Internation Human Rights and Refugee Law)* • *The Red Cross and other International NGO's (who support the Code of Conduct)* • *International support (for the Mauritius Strategy for the Sustainable Development of Small Island Developing States)*
Through Structural Measures	• *Governments* • *Regional Intergovernmental Organisations* • *UN System* • *Other International Organisations* • *International Financial Institutions (IFI's)* • *Non-Governmental Organisations* • *Private Sector* • *Media* • *Academic Institutions*	***[To be completed]***	• *UN Agencies (supporting the Millennium Development Goals) (MDG)* • *The United Nations Development Assistance Framework* • International Organisations (promoting ISO Standards) • World Trade Organisation (WTO) • *WHO and other International Health Organisations (who promote International Health Regulations)* • *International Humanitarian, Rights organisations (who promote Internation Human Rights and Refugee Law)* • *The Red Cross and other IOnternational NGO's (who support the Code of Conduct)* • *International support (for the Mauritius Strategy for the Sustainable*

			Development of Small Island Developing States)
Through Risk Sharing/ Transfer	• *International Financial Institutions (IFI's)* • *Insurance and Re-Insurance companies* • *Development organizations* • *International NGO's*	***[To be completed]***	• *The Hyogo Framework and the Bali Action Plan both mention Risk Sharing and Transfer* • *UNFCCC and the Kyoto Protocol both mention considerations of insurance instruments*
Notes: 1. Due to the large number of actors involved in international risk reduction, collective descriptions are noted in this table, rather than attempting to list individual organizations. 2. All the actors noted on this table perform international, roles, normally working in partnerships with national governments and institutions			

Table 7-3: Linkages of MDGs to DRM and CCA.

Goal	Negative impact of extreme events on MDG achievement	Benefits of MDG achievement for DRM and CCA
Eradicate extreme poverty and hunger	Impact on livelihood sustainability, food security Indirect impacts on macroeconomic growth and social support	Increased socioeconomic resilience (ability to buy goods and services following extreme events) Increased biological resilience (resistance to disease during famine)
Achieve universal primary education	Damage to educational infrastructure, Population displacement and the occupation of schools Reduction in household assets, more need for children to work rather than attend school	Improved ability to participate in community-based DRM activities
Promote gender equality and empower women	Higher female mortality in some extreme events Greater workloads and lower food entitlements after disasters. Social disruption leading to exposure to sexual violence Potential reinforcement of power inequalities between men and women	Potential for more equitable and effective DRR through empowerment of women to participate in or lead community based action (e.g. from Latin America).
Reduce child mortality	Increased hazards to which children are particularly vulnerable (heat stress, physical injury in storms and floods, food insecurity). Potential for disasters to exacerbate other socioeconomic determinants of child health (e.g. extreme poverty, armed conflict and infectious disease).	Enhanced population resilience to extreme events Enhanced motivation for long-term sustainable planning, including family planning
Improve maternal health	Damage to health infrastructure Shocks, stresses and erosion of household assets for pregnant women	More resilient maternal health infrastructure and practice reduces vulnerability to extremes
Combat HIV/AIDS, malaria and other diseases	Enhanced transmission of environmentally mediated diseases, such as diarrhoea and malaria, in some circumstances Loss of livelihood and population displacement leading to higher-risk sexual behaviour. Food insecurity leading to decreased immunity to infectious disease	Increased human resource capacity within health, emergency and other services (healthier staff) Reduced competition for scarce resources (less effort diverted to treating disease)
Ensure environmental sustainability	Physical damages to aquatic and land-based ecosystems. Damages to infrastructure for managing environmental health risks (e.g. water and sanitation infrastructure)	Enhanced ecosystem service of protection from natural disasters (e.g. flood protection and water filtration) Less extreme climate change, and associated hazards
Develop a Global Partnership for Development	Inequitable damages to least developed countries, particularly those with high physical exposure (e.g. small island develops states)	More equitable and efficient burden sharing between developed and developing countries.

Adapted from Schipper and Pelling (2006).

Table 7-4: 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)

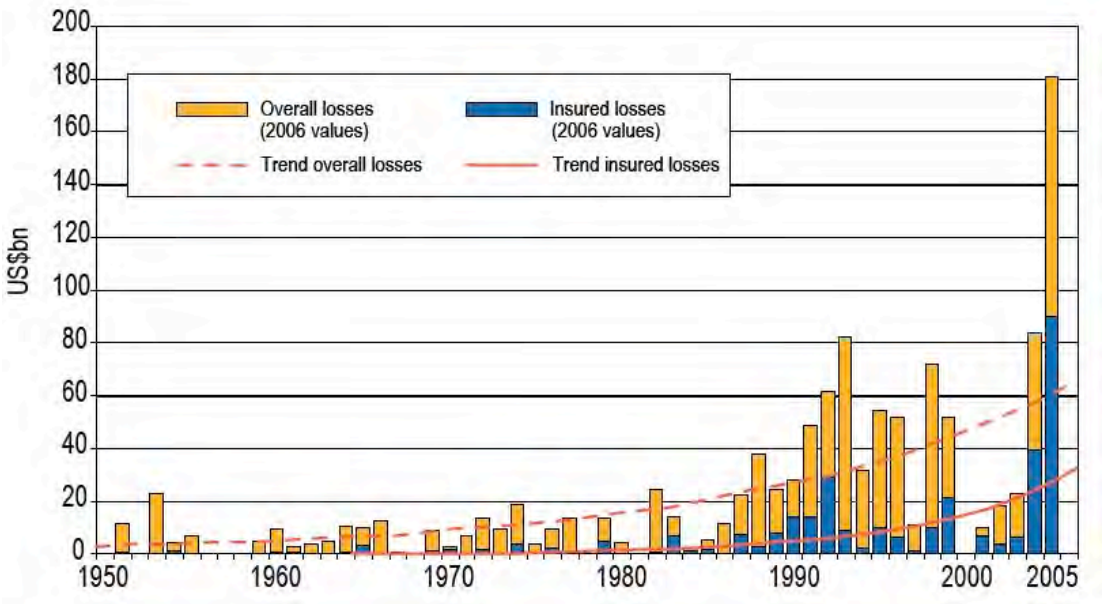

Figure 7-1: Overall and insured losses from great natural catastrophes, 1950-2006 (Munich-Re, 2007).

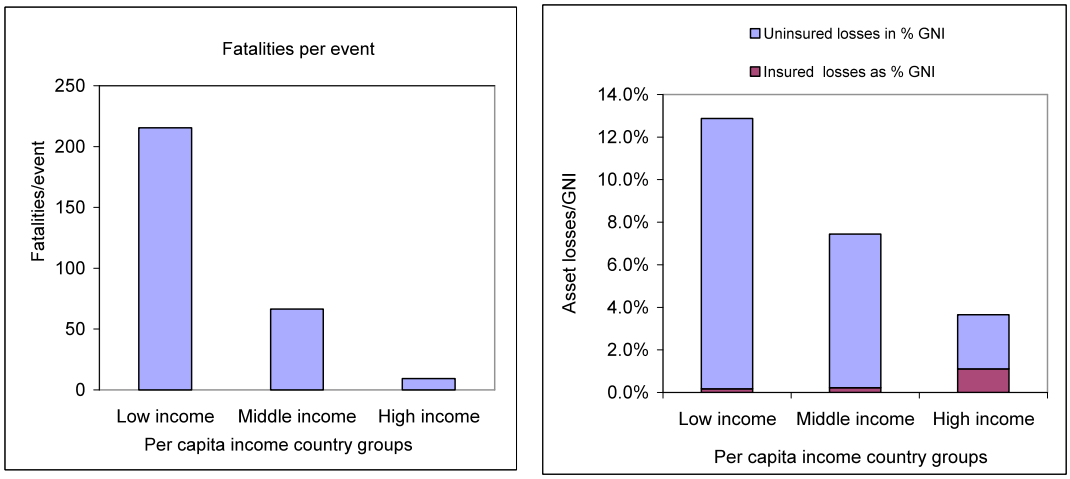

Figure 7-2: Differential burden of natural disasters according to country income groups (Linnerooth-Bayer et al., 2010; based on data from Munich Re, 2005) (Note: country income groups according to World Bank classification).