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Mechanisms to manage financial risks from direct impacts of climate change in developing countries

Technical paper

Summary

This technical paper provides information on the financial mechanisms used to manage risks from the direct impacts of climate change. The mechanisms described include both insurance mechanisms and other forms of risk spreading and sharing, referred to as non-insurance mechanisms.

Developing countries require a portfolio of mechanisms, which may include insurance, to manage risks, as no one mechanism can meet the range of circumstances required by all countries. The paper considers hazards, assets and vulnerability in the context of climate change, and reviews several options for managing financial risks from impacts of climate change in developing countries. It also proposes three innovative financing schemes for this purpose. The role of external support in helping developing countries finance appropriate risk-sharing mechanisms is part of this consideration.

Parties may use the information contained in this technical paper as they consider implementing adaptation action under the Convention, particularly in the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention on enhanced action on adaptation, including the in-session workshop on risk management and risk reduction strategies. The information could also be considered by Parties and organizations in their actions to manage financial risks from the direct impacts of climate change and to enhance resilience to the impacts of the adverse effects of climate change.

CONTENTS

I. Executive summary

1. The Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) at its second session requested the secretariat, subject to the availability of financial resources, to prepare and make available for consideration at its fourth session (FCCC/AWGLCA/2008/8)[1] a technical paper on mechanisms, including innovative insurance tools, that can be used to manage financial risks from direct impacts of climate change in developing countries, including consideration of the unique circumstances of the most vulnerable developing countries, especially the least developed countries (LDCs), small island developing States (SIDS) and countries in Africa, and the design of appropriate mechanisms bringing together inputs from technical experts in the fields of insurance, reinsurance and hazard assessment.[2]

2. Adaptation is essential in order to lessen the severity and cost of climate change impacts by reducing vulnerability through a wide range of interventions. Market insurance and other financial risk-transfer solutions can be part of an adaptation plan to enable vulnerable countries to manage the new climate risks due to climate change. It would be necessary to examine the interplay and potential synergy between these different potential solutions, including insurance-related actions.

3. In addition to conventional and indexed insurance instruments, there are opportunities for considering non-insurance instruments as part of the adaptation provisions of a 2012 climate change agreement. In some contexts, conventional financing approaches can be less costly than catastrophe insurance instruments for funding climate-related risks. However, it is acknowledged that access to conventional financing approaches has proved insufficient to meet the needs of developing countries in reducing their exposure to climate risks and assuring timely capital for disaster reconstruction and adaptation measures.

4. The critical task at hand is to create financial risk-sharing and risk-management approaches and mechanisms that can help developing countries, especially LDCs, SIDS and countries in Africa, to reduce their vulnerability to the impacts of climate change. Climate-related disasters represent a major source of risk for the poor in developing countries, and the losses caused are seen as a major threat to the achievement of the United Nations Millennium Development Goals (MDGs). Immediate adaptation action is required, as the economic costs of climate-related disasters are high, and continuing to rise. Costs totalled USD 1 trillion worldwide from 1980 through 2003.[3]

5. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) noted that the climate system is warming, leading to increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea levels. For the next two decades, a warming trend of about 0.2 °C is projected for a range of greenhouse gas (GHG) emission scenarios; and even if the concentration of all greenhouse gases and aerosols is kept constant at year 2000 levels, a further warming of about 0.1 °C per decade is expected.

6. As a consequence, it is anticipated that sea levels and global sea water temperature will increase, and that weather patterns will change, resulting in an increase in the frequency and intensity of extreme events. According to the IPCC, LDCs have contributed the least to the emission of GHGs but they are the most vulnerable countries to the effects of climate change and have the least capacity to adapt to these changes.

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[1] FCCC/AWGLCA/2008/8.
[2] FCCC/AWGLCA/2008/8, paragraph 28 (b).
[3] CRED 2006.

7. Several international agencies, including the UNFCCC secretariat,[4] the United Nations Development Programme (UNDP),[5] the World Bank,[6] the Organisation for Economic Co-operation and Development (OECD) and Oxfam,[7] as well as the Stern Review on the economics of climate change[8] have estimated adaptation costs for developing countries that range from a high of USD 86–109 billion a year (UNDP) to a low of USD 4 billion a year (Stern Review) to adapt to climate change. The Stern Review also estimated that inaction could cost up to 20 per cent of global GDP.[9]

8. This paper provides a review of innovative financial tools in climate change risk management. Some of them are already operative, but not in widespread use, and some are proposals that have not yet been piloted or tested. These risk-transfer mechanisms or schemes may be attractive both to potential insurers and to governments. They provide incentives to countries to adopt adaptation measures while helping eliminate moral hazard.[10] The potential schemes presented in this paper also address some of the serious challenges faced by developing countries, particularly the most vulnerable (LDCs, SIDS and countries in Africa) in obtaining climate insurance. Fewer than 5 per cent of households and businesses in developing countries have insurance coverage for catastrophe risks. Instead, such risks are dealt with by a mix of social networks and informal post-event credit. Lack of insurance may also stunt development because smallholders cannot risk investing in fixed capital or concentrating on profitable activities and crops for fear of losing them, and falling into debt.

9. Development of the new climate-related risk-transfer and risk-sharing mechanisms proposed in this paper has factored in a number of issues faced by LDCs, SIDS and countries in Africa, including their high vulnerability to climate change; low level of ability to mitigate natural disasters; underdevelopment of insurance markets; susceptibility to changes in international markets; lack of financial means for adapting to the effects of climate change; and lack of capacity to manage the financial risks from the direct impacts of climate change, thus placing sustainable development and poverty reduction at great risk.

Hazards, assets and vulnerability

10. Climate change is likely to affect a range of assets. Assets do not have to be financial; they can be of any kind, such as agricultural harvests, livestock, infrastructure or intangible assets such as public services and human life itself. The likely hazards as a result of climate change and its effects on assets are considerable, although not known precisely. Some risks are long-term and inevitable, such as sea level rise, and for many the risks are difficult to quantify, such as the effect on ecosystems, livelihoods and cultural capital. Costs could be significantly reduced by risk reduction measures, resilience building and climate change adaptation, but this would still leave a residual risk, which would have a particularly harsh impact on the poor.

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[4] Report on the analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change. <http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf>.

[5] United Nations Development Programme. 2007. *Human Development Report 2007/2008. Fighting Climate Change: Human Solidarity in a Divided World.* Available at: <http://hdr.undp.org/en/reports/global/hdr2007-2008/>. Chapter 4.

[6] World Bank. 2006. *Clean Energy and Development: Towards an Investment Framework.* Washington, D.C: World Bank. Available at: <http://siteresources.worldbank.org/Devcommint/Documentation/20890696/DC2006-0002(E)-CleanEnergy.pdf>.

[7] Raworth K. 2007. *Adapting to Climate Change: What's Needed in Poor Countries and Who Should Pay*. Oxfam International. Available at: <http://www.oxfam.org/en/files/bp104_climate_change_0705.pdf/download>.

[8] Stern, 2007.

[9] Stern, 2007.

[10] The tendency to relax vigilance, or adopt riskier strategies, when insurance has been arranged.

11. There are insurance products in developed countries and pilot schemes in developing countries which could provide valuable risk-pooling services for the vulnerable against hazards due to climate change that are short-term and acute, and where there is a spatial and temporal uncertainty of impact, as with droughts and hurricanes. However, it has proved difficult to scale up these products, owing to lack of awareness, weak financial infrastructure and absence of databases of risk-relevant information.

12. The mechanisms available to manage financial risks have been improved over time, partly through the development of new modelling techniques for estimating and pricing the risks of natural disasters. The private sector and the donor community are now in a better technical position to help the poor pre-emptively cope with the economic repercussions of disasters and a wide array of climate change related risks. Such help is made possible by the advent of novel insurance and non-insurance instruments for transferring catastrophe risks to the global financial markets. Sources of financing risk-transfer programmes would not only leverage limited disaster-aid budgets but also facilitate reducing dependency of recipient countries on post-disaster assistance. Both donors and recipients stand to gain, especially because the instruments can be closely coupled with preventive measures, including adaptation to reduce risk, vulnerability and exposure.

13. Even with the successful development and deployment of existing and new risk-transfer mechanisms, the vulnerable would still be at risk from climate hazards. Owing to the increased interdependence of global economy and society, impacts in poor and vulnerable regions could cascade throughout the world. It would therefore be cost-effective as well as equitable for the international community to contribute to managing these risks. An earlier proposal for an "international insurance pool" was made by the Alliance of Small Island States, which suggested an insurance pool to be funded by developed countries to compensate small island and low-lying developing countries for the otherwise uninsured loss and damage from slow-onset sea level rise.[11]

Insurance mechanisms to handle climate-related risks

14. There is a wide range of insurance models, from informal social arrangements, community schemes such as microinsurance and mutual insurance, to formal insurance where funds are collected by a profit-making third party, and reinsurance, which accepts risks that are too severe for smaller schemes or operators to retain. In developed countries, insurers adapt to the growing climate-related risk to property by raising insurance premiums, restricting or removing coverage, using reinsurance and more efficient loss adjustment. In addition, insurers frequently seek to collaborate with governments to arrive at sustainable or resilient approaches in development or regulation.

15. Private-sector insurers can play an important role by freeing up public resources for other priority needs. The private sector can support the high-risk or high-cost functions that the public sector performs in a public–private partnership.

16. National adaptation plans could provide the basis for public–private partnerships to manage the economic costs of climatic impacts through insurance. Key areas for public finance include funding for public goods such as risk-relevant data (e.g. weather maps) and major hazard reduction projects (e.g. flood control). Feasibility studies including demonstration or pilot insurance schemes could also be funded.

17. Many classical insurance products have proved to be non-viable in developing countries. The primary obstacles are the weakness of the rural financial sector and the high-expense structure of conventional insurance. From an insurer's viewpoint, the significant barriers include the highly skewed nature of disaster risks, lack of data, restrictive regulations, small scale of operations and potential for moral hazard.

[11] Hayes P and Smith K (eds.) 1993. *The Global Greenhouse Regime. Who Pays?* Part II. Chapter 7. Appendix. London: Earthscan Publications. (A/AC.237/MISC.1/Add.3).

18. Recent technical innovations have improved the possibilities of using insurance in developing countries – geographic information systems make it possible to model and price risks with low probability but high loss potential; index-based insurance contracts provide a low-cost alternative to traditional loss-based insurance; and novel mechanisms for transferring catastrophe risks to the global financial markets are opening new windows for reinsurance arrangements. In addition, new organizations like microfinance institutions (MFIs) have emerged to service the low-income sector, providing credit and additional services such as microinsurance, either bundled by linkage to a loan, or on a stand-alone basis, targeted specifically at weather risks.

19. Indexed insurance instruments such as catastrophe bonds and weather derivatives could help developing countries, particularly rural communities, to cope with the impact of extreme events. Advantages include low moral hazard and adverse selection; no expensive loss adjustment for small units; less complex data requirements; less complex contracts; and rapid payout. The main disadvantage is basis risk: the risk that the participants' losses may not correlate with the index. However, there are still practical hurdles to overcome with these products. Considerations for weather derivatives include low distribution in rural areas, the unfamiliarity of the public with insurance and the lack of weather data, as well as the lack of capacity to introduce such systems nationally because of the high level of technical and financial expertise required. At the state level, catastrophe bonds offer comparable opportunities to weather derivatives, but there has been less experience with these.

20. The development of microfinance and microinsurance for low-income communities offers great promise in addressing economic risks related to the climate. Initial experience indicates that these products can be viable without subsidies once the initial costly research and development has been accomplished. Furthermore, it is possible to link microinsurance to the financing of adaptive measures such as agricultural improvements, so that resilience is enhanced.

Potential financial solutions for developing countries

21. This paper presents three innovative financial mechanisms with potential to provide a meaningful risk-transfer option for developing countries. The financial mechanisms are designed for governments and populations of countries affected by climate change, but can also depend significantly on support from the international community. The three schemes are not mutually exclusive. They can be used, if Parties decided to promote or establish them, as separate or joint financial risk management strategies. Table 1 provides an overview.

22. Scheme A would apply in a situation where the underlying risks are insurable, but the insurance market has not started up owing to regulatory or informational barriers, for example. It is the simplest scheme; it can be adopted with immediate effect, and applies to single countries. It consists of removing the constraints with external support, such as database compilation, technical training, improved regulatory framework and financial risk management advice; and transferring as much risk as is feasible and efficient to the global reinsurance markets.

23. Under scheme A, the population (small farmers and low-income groups) and the government transfer risks directly to their own insurance companies. In addition, for the government, there are several types of financial agent that could carry the risks (e.g. banks or national cooperatives), subject to the local regulation.

24. The risks of the population and the government would be concentrated through insurance companies and from there transferred to the reinsurance market. The risks are handled in two instruments: insurance (risk-transfer) and retention. This type of financial structure typically works for one year and would then need to be renegotiated annually.

Table 1. Overview of possible climate change related risk-transfer and risk-sharing schemes for developing countries, especially least developed countries, small island developing States and countries in Africa

Scheme A Single insurance policy (individual countries)	Scheme B Single insurance policy (for a group of countries)	Scheme C Climate change risk management mechanism
• Underlying risks are insurable • Applied per country • Short-term solution (renegotiated annually)	• Underlying risks are insurable • Applied to a set of countries • Short-term solution (renegotiated annually)	• Addresses uninsurable risks • Explicit risk reduction • Applied globally • Flexible term • Long-term solution
PURPOSE		
The aim of this scheme is to manage the financial impacts of climate change risks. These should be quantified in the risk assessment, which should detail the assets and the kind of hazards involved.	This scheme also aims to manage the financial impacts of climate change risks. The scheme entails support by external entities, like multilateral organizations and donors to support its establishment and the provision of technical advice.	One element involves coordination of international support by providing technical support in the area of climate risk management. A second element transfers financial risk by insurance or risk securitization in a very broad range of financial instruments.

25. Scheme B is built on the participation of several interested countries or sets of countries (for example SIDS, LDCs and/or countries in Africa). The assets covered come from housing of low-income populations, small farm producers and potential losses for governments. Scheme B applies to a situation where a group of countries has insurable risks, but the insurance market has not developed owing to various barriers, which can be resolved with external support. The scheme addresses a set of risks arising from different types of hazards and assets. The scheme's strengths include diversifying the risks geographically, by sector and by assets, and providing a critical mass of negotiating power in the international financial markets.

26. The risks can be focused in a reinsurance pool controlled by the syndicate of the participating countries. Part of the risk can be transferred to the capital markets from the reinsurance pool. Like scheme A, this type of financial structure typically works for one year and would then need to be renegotiated annually.

27. Scheme C is an international solution built on the participation of larger parts of the international community. This scheme enables the insurance of risks that may otherwise be uninsurable, especially in LDCs, SIDS and countries in Africa. It is designed for governments and local populations of those countries affected by climate change and is designed to benefit from external support. The scheme bears some similarities with a risk management programme recently proposed by the Munich Climate Insurance Initiative, which is also described in this paper.

28. Under this scheme, the participating country will manage risks associated with population losses (crops and housing) and government losses (infrastructure and liquidity for emergency expenses). Local populations can channel their risks into the international financial markets through an intemediary: either local cooperatives supported by non-governmental organizations (NGOs), government and multilateral organizations or in some countries through insurance companies.

29. The mechanism has two fundamental components. The first component is a technical advisory facility created to provide advice to countries on risk management techniques in the context of climate change. The facility will advise on financial subjects and physical modelling of the risk. It could be the

backbone of the risk management strategy for each set of participating countries and provide the link with multilateral support entities and risk reduction agencies.

30. The second component of the mechanism is an optional financial vehicle that gives countries access to better premiums and greater coverage. It regulates the use of a responsibility fund that accumulates resources provided by industrialized countries and of the premiums of countries that decide to use the vehicle as a reinsurance facility.

Non-insurance mechanisms for managing climate-related risks

31. Non-insurance mechanisms, together with insurance mechanisms, belong in a portfolio of financial mechanisms for the facilitation and support of adaptation to the impacts of climate change. Non-insurance mechanisms can be an important and cost-effective part of an adaptation financing strategy.

32. Non-insurance mechanisms can be divided into three main types: informal risk sharing; intertemporal risk spreading; and collective loss sharing (solidarity). In some cases, non-insurance mechanisms can be less costly than insurance mechanisms for financing climate-related risks. In contrast to insurance, non-insurance mechanisms can:

(a) Provide direct financing for adaptation measures that reduce chronic climate impacts, such as responding to salt water intrusion, as well as measures that address sudden-onset events, such as building dykes or levees;

(b) Serve communities that do not have insurance institutions in place, or an insurance culture;

(c) In some contexts offer a lower-cost alternative to insurance for providing post-disaster capital, especially for low-level risks;

(d) Redistribute climate-impact burdens from the poor with national and international solidarity.

Final remarks

33. Both insurance and non-insurance financial mechanisms potentially have a major role to play in an expanded and strengthened adaptation response to climate change risks. The need for such an expanded and strengthened response has been widely accepted in recognition of the added burden that climate change impacts are imposing on the development process. Adaptive capacity is being further undermined by climate change impacts and exposure of vulnerable countries and communities is increased. This means that LDCs, SIDS, countries in Africa and other vulnerable countries risk are becoming caught in a downward spiral of increasing climate change risks and diminishing capacity to manage them.

34. Consideration will be needed on the relationship between private insurance and reinsurance and the role of external support in helping the poor and the most vulnerable to manage their risks. There is a wide portfolio of mechanisms ranging from fully private insurance to fully humanitarian assistance. Between these two poles are a number of blended products or options exemplified by public–private partnerships. The choice and mix of these products is an important element in the design of any new and strengthened adaptation strategy or regime.

35. Current and innovative financial and non-financial mechanisms and innovative insurance tools can thus play a constructive role in a strengthened and expanded adaptation strategy or regime. Parties can consider appropriate mechanisms from the whole portfolio of options to respond to their specific needs and circumstances arising from the adverse effects of climate change. The choice and mix of

products is an important element in the design of any new and strengthened adaptation strategy or regime.

36. Parties may use the suggestions on the insurance and non-insurance financial mechanisms discussed in this paper as they consider implementing adaptation action under the Convention, especially in the work of the AWG-LCA. This information can be used by Parties at the in-session workshop under the AWG-LCA on risk management and risk reduction strategies, including risk-sharing and risk-transfer mechanisms, to be held at the fourteenth session of the Conference of the Parties (COP) in Poznan, as well as in the negotiations of the Bali Action Plan (decision 1/CP.13) on enhanced action on adaptation towards an agreement during COP 15 in Copenhagen.

II. Introduction

A. Mandate

37. The AWG-LCA, at its second session, requested the secretariat to prepare and make available, for consideration at its fourth session, a technical paper on mechanisms, including innovative insurance tools, that can be used to manage financial risks from direct impacts of climate change in developing countries, including consideration of the unique circumstances of the most vulnerable developing countries, especially LDCs, SIDS and countries in Africa; and the design of appropriate mechanisms bringing together inputs from technical experts in the fields of insurance, reinsurance, and hazard assessment.[12]

B. Objective

38. This technical paper aims to provide a synthesis of present knowledge and understanding of mechanisms that can be used to manage financial risks from direct impacts of climate change in developing countries. It also describes some innovative ideas that have not yet been fully tested and tried out in pilot programmes. Both insurance and non-insurance mechanisms are identified, and the advantages and disadvantages of each are described. The need for this analysis is made clear by an examination of the types of hazards being exacerbated by climate change, and the effect of these hazards on the poor and the most vulnerable. Losses have been increasing over time, and there is potential for considerable further increase unless adaptation measures can be strengthened and intensified.

39. This paper draws and builds upon two technical papers prepared under the Nairobi work programme on impacts, vulnerability and adaptation to climate change. These cover “Physical and socio-economic trends in climate-related risks and extreme events, and their implications for sustainable development”,[13] and “Integrating practices, tools and systems for climate risk assessment and management and disaster risk reduction strategies into national policies and programmes”.[14] The former provides evidence for the mutually reinforcing nature of climate and socio-economic change. The latter technical paper identifies the factors that shape the integration of the needed responses to climate risks into national policies and programmes, as a necessary pillar of effective adaptive action. Climate change effects adversely impact the poorer and more vulnerable, and this in turn reduces adaptive capacity and increases exposure such that subsequent climate-related hazard events have an increasing impact. Unless this downward cycle can be broken, the poor and most vulnerable risk becoming indefinitely trapped. The mechanisms discussed in this paper can be directed towards avoiding this outcome.

[12] FCCC/AWGLCA/2008/8, paragraph 28 (b).
[13] FCCC/TP/2008/3.
[14] FCCC/TP/2008/4.

C. Background

40. Climate change affects all nations, but three groups of countries – LDCs, SIDS and countries in Africa – are especially vulnerable. Localized human-induced vulnerabilities, such as over-fishing, pollution, increased coastline development and unsustainable use of water resources, will all magnify climate vulnerabilities. The following will be particularly vulnerable:

(a) Coastal and river flood plains;

(b) Economies linked with climate-sensitive resources;

(c) Areas prone to extreme weather events;

(d) Poor communities with low adaptive capacity.

41. Disasters represent a major source of risk for the poor in developing countries. From 1987 to 1998, the annual number of climate-related disasters averaged 195. From 2000 to 2006, the average was 365, representing an increase of 87 per cent.[15] About three quarters of all disasters were triggered by weather-related events during the 1990s, and floods and drought are among the most prominent causes.[16] More than 95 per cent of all deaths caused by natural disasters occur in developing countries; and losses due to natural disasters are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries.[17]

42. Reducing the human, social, economic and environmental losses due to climate-related hazards will become increasingly difficult to achieve, with projections warning of more intense and more frequent climate-related events. The Stern Review estimated that if no action were taken to mitigate climate change, damages could cost up to 20 per cent of global GDP.[18] Failure to implement adaptation practices could compound the situation. Several sources, including the UNFCCC secretariat, UNDP, the Stern Review, the World Bank, OECD and Oxfam, have estimated adaptation costs for developing countries that range from a high of USD 86–109 billion a year (UNDP) to a low of USD 4 billion a year (Stern Review) to adapt to climate change.

43. There is a growing recognition that adaptation practices go hand in hand with disaster risk reduction strategies, as both aim to reduce vulnerabilities and minimize threats to human security. Disaster risk reduction strategies are critical to reducing risk and vulnerability to natural and related technological and environmental hazards. In the Bali Action Plan (decision 1/CP.13), risk management and disaster risk reduction are identified as important elements of adaptation.

44. Adaptation aims at moderating the adverse effects of climate change by reducing vulnerability to climate effects through a wide range of interventions. The use of financial risk-sharing mechanisms to address climate change is one such intervention. Market insurance and risk-transfer solutions – climate insurance – can be part of the solution in enabling disaster-prone countries to successfully manage the new climate risks on the horizon.

45. The economic costs of climate-related events are high, totalling USD 1 trillion worldwide in 1980–2003. During this period, insurance covered 4 per cent of total costs of climate-related disasters in developing countries, compared with 40 per cent in high-income countries. The most widely discussed insurance-related consequences of climate change are the impacts of property damage from extreme

[15] United Nations General Assembly document A/62/323, chapter 1.A., paragraph 4.
[16] GECHS, 2008.
[17] World Bank. 2007c.
[18] Stern, 2007.

weather events – the insured share of losses has risen from a negligible level in the 1950s to approximately 20 per cent of the total today.[19]

46. Currently, many developing countries, especially LDCs, SIDS and countries in Africa, face serious challenges in obtaining natural disaster insurance. They are highly vulnerable and the least equipped of all countries to mitigate natural disasters; they have limited capacity to spread risk geographically; their insurance markets are vulnerable to changes in the international markets and they have underdeveloped non-life insurance markets; they lack the financial means for adapting to the adverse effects of climate change; and they lack the capacity to manage the financial risks from the direct impacts of climate change, which threatens sustainable development and poverty reduction.

47. Nevertheless, there have been positive developments at the macro and micro level, with insurance cover for humanitarian emergencies in Ethiopia in the event of extreme drought, regional index-based insurance against government losses caused by natural disasters in the Caribbean, and many pilots of microinsurance providing, for example, simple weather derivatives for low-income segments, particularly for drought in India.

D. Scope of the paper

48. The document aims to provide the Parties to the Convention with information that will facilitate the identification of elements that could be considered for the adaptation provisions of an agreed outcome of the negotiations launched by the Bali Action Plan, particularly on financial risk-sharing and risk-management mechanisms.

49. The paper brings together inputs from technical experts in the fields of insurance, reinsurance and hazard assessment, as well as relevant information and experience in the context of the UNFCCC process. In this regard, the technical paper proposes creative risk-transfer mechanisms for developing countries, including LDCs, SIDS and countries in Africa, details creative financial solutions and makes specific recommendations for immediate and long-term implementation.

50. The paper consists of seven chapters:

(a) The present chapter provides background information, including definitions, assumptions and a brief explanation of climate-related risks and extreme events in the context of sustainable development and its possible reversal as a result of climate change. It also covers risk reduction and the nature of moral hazard, and existing resources for responding to extreme events. The chapter also highlights the unique circumstances of the most vulnerable developing countries, especially LDCs, SIDS and countries in Africa;

(b) Chapter III highlights the types of hazard, the kinds of asset at risk, including intangible assets (e.g. human life), and the vulnerability of those assets to direct impacts of climate change. It also briefly investigates the magnitude of historical losses from natural disasters and addresses the potential losses, taking into account the additional burden of climate change, including the cause and the physical and temporal scale;

(c) Chapter IV reviews insurance-related financial mechanisms and provides systematic analysis of the gaps and barriers in implementing them. Examples of initiatives that already exist are provided;

(d) Chapter V presents a range of potential financial options in risk management linked to climate change, designed to reduce the impact in the public and private sectors. The financial options include, among others, innovative insurance tools that allow

[19] Mills, 2004.

opportunities for public–private partnerships and that provide support for SIDS, LDCs and countries in Africa;

(e) Chapter VI reviews non-insurance mechanisms for coping with climate and weather variability and extremes in highly vulnerable developing countries, and for providing necessary capital to finance a range of climate adaptation measures. The aim is to illustrate that a wide portfolio of financial measures is available, alongside insurance mechanisms, for adaptation;

(f) Chapter VII draws together the conclusions of the preceding chapters to clarify what actions and further research is required.

E. Context

51. In considering mechanisms to manage financial risk in the face of climate change, it is important to provide a brief explanation of climate-related risks and extreme events in the context of sustainable development and the possible reversal of sustainable development as a result of climate change. This section provides an overview of the trends in natural disasters, particularly climate change related hazards, and highlights the unique circumstances of the most vulnerable developing countries, especially LDCs, SIDS and countries in Africa.

1. Climate-related risks and extreme events – a major sustainable development challenge

52. The AR4 noted that warming of the climate system is now evident from increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea levels. Eleven of the years 1995 to 2006 rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850).

53. Previous IPCC projections of a temperature rise of between 0.15 to 0.3 °C per decade are now supported by an observed global value of 0.2 °C per decade. For the next two decades, a warming trend of about 0.2 °C is projected for a range of GHG emission scenarios. Even if the concentration of all GHGs and aerosols is kept constant at year 2000 levels, a further warming of about 0.1 °C per decade is expected.

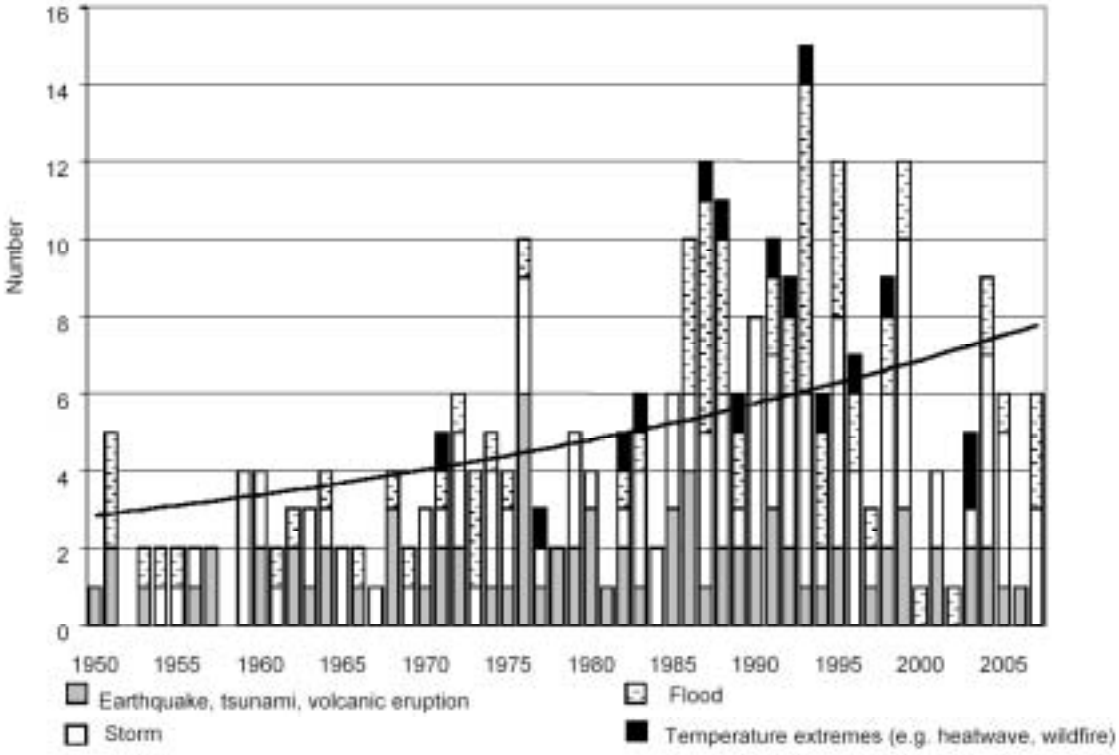
54. As a consequence, it is expected that sea levels and global sea water temperature will increase, and that weather patterns will change, resulting in an increase in the frequency and intensity of extreme events (heatwaves, droughts and floods) and possibly hurricanes. According to the IPCC, LDCs have contributed little to the emission of GHGs but they are the most vulnerable countries to the effects of climate change and have the least capacity to adapt to these changes.

55. In 2007, tens of millions of people in Asia were affected by floods, particularly in Bangladesh, China, India and Nepal. In Bangladesh, Cyclone Sidr killed more than 5,000 people. Most recently, in May 2008, Cyclone Nargis killed over 84,500 people in Myanmar – 61 per cent of those who died were female – and almost 54,000 people are still missing. More than 19,000 were injured. Assessment data show that some 2.4 million people in Myanmar were severely affected by the cyclone, out of an estimated 7.35 million people living in the affected townships.[20]

56. In Africa, drought and flooding affected millions of people in 2007. In the Horn of Africa alone, more than 10 million people were left dependent on food aid and support as a result of droughts. Cycles of flooding in Southern Africa affected more than 1 million people and killed hundreds. Madagascar and Mozambique were the worst affected owing to five successive cyclones that hit between December 2006 and March 2007. The last two cyclones alone affected an estimated 190,000 people and killed 150.

[20] ReliefWeb, 2008.

Figure 1. Major natural disasters, 1950–2007



Source: Münchener Rückversicherungs-Gesellschaft Geo Risks Research, NatCatSERVICE.

57. Figure 1 shows a distinction between climate-related disasters and geological ones. The former have increased in number decade after decade, while non-climatic events have been stable. One possible explanation is that the incidence of climate-related disasters is influenced by climate change. It is certainly set to be a more powerful force as it continues and accelerates.

58. These statistics measure the occurrence of disasters and not simply the hazard events themselves. The increase in weather-related and hydro-meteorological disasters cannot be attributed only to climate change on the basis of this information. The information shows that losses from climate-related weather events have been increasing. Without a greatly strengthened adaptation effort, this trend of increasing weather-related disaster losses is likely to become much greater and more damaging to present and future development. The key point is that climate change risks and losses are additional to a situation which is already deleterious to development.

59. In addition, the socio-economic trends show that major challenges lie ahead for people in developing countries. While developing countries are diverse, they share several common socio-economic characteristics: low standards of living, including low incomes, high rates of poverty, inadequate housing, poor human health, malnutrition, limited or no education, high infant mortality rates and low life expectancy; dependence on agriculture; dependence on primary exports; rapid urbanization; and, more noticeably, the challenges of rising food and oil prices and inflation.

60. The 2.6 billion people in developing countries – 40 per cent of the world's population – who live on less than USD 2 a day are intrinsically vulnerable because they have fewer resources with which to manage.[21] For those living in areas marked by drought and low productivity, there are high levels of malnutrition, particularly in countries in Africa. Disaggregated Human Development Index data for

[21] UNDP, 2007b.

Kenya, for example, show a close fit between food emergencies linked to drought and districts where human development is low.

61. About 75 per cent of the world's poor live in rural areas and are involved in farming. Agriculture represents a significant fraction of GDP in developing countries, from a high of 32 per cent in sub-Saharan Africa to a low of 5 per cent in SIDS. The benefit to the poor of development of agriculture activities could be of a magnitude two to four times larger than the benefit of making changes in other sectors.[22]

62. Many developing countries depend on a single commodity as primary export, which is one of the reasons for their vulnerability. Thus, a single climate-related hazard can destroy a nation's agriculture sector. For example, in 2004, Hurricane Ivan caused damage in excess of 200 per cent of Grenada's GDP, destroyed the agriculture sector and decimated the island's well-known nutmeg industry (which represents 80 per cent of agricultural exports). It will take seven to 10 years for the industry to recover. In Samoa, two cyclones that struck in 1990 and 1991 set back its development by 20 years, while in Mozambique the 2000 floods caused the annual GDP growth to fall from 10 to 2 per cent.[23]

63. Reducing the severity of climate change induced disasters implies addressing development challenges and equipping communities with additional coping capacity. Community-based disaster management is becoming an integral part of any local or national disaster management planning. At the international level, the Hyogo Framework for Action is a guide for disaster reduction efforts and offers guiding principles, priority areas and practical means of achieving disaster resilience in vulnerable communities. The Bali Action Plan includes disaster risk reduction in its adaptation element, and other adaptation mandates under the UNFCCC process have promoted efforts to integrate disaster risk reduction and climate change adaptation into national planning and policies.

2. Least developed countries

64. For a country to be classed as an LDC (least developed country) it must satisfy three criteria: it must have low income (per capita gross national income under USD 750), have a human resource weakness and be economically vulnerable.[24] The current list of LDCs includes 49 countries – 32 in Africa, 16 in Asia and the Pacific and one in Latin America. In 2005, LDCs had a combined population of 750 million, which is equivalent to about 12 per cent of the world's population,[25] but their share of the world's GDP is less than 1 per cent.[26] In 2005, about 40 per cent of the total population of LDCs lived in extreme poverty (that is, under USD 1 a day) and the number of poor people was larger than it was in 2000.[27]

65. Agriculture is central to livelihoods, employment and the economy in many LDCs. It accounts for 30–60 per cent of GDP among the LDCs, employs more people than any other sector (around 70 per cent in most cases), represents a major source of foreign exchange, supplies the bulk of basic food and

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[22] World Bank, 2007b.
[23] WMO, 2006.
[24] The population of an LDC must be below 75 million. The gross national income (GNI) value is based on a three-year average estimate of the per capita GNI (under USD 750 for inclusion, above USD 900 for graduation). Human resource weakness is calculated from a composite Human Assets Index based on indicators of nutrition health education and adult literacy. Economic vulnerability is calculated from a composite Economic Vulnerability Index based on indicators of: the instability of agricultural production; the instability of exports of goods and services; the economic importance of non-traditional activities (share of manufacturing and modern services in GDP); merchandise export concentration; the handicap of economic smallness (as measured through the population in logarithm); and the percentage of population displaced by natural disasters (UN, 2004).
[25] UN-OHRLLS and World Bank 2006.
[26] UNCTAD, 2006.
[27] UNCTAD, 2008.

provides subsistence and other income to more than half of the countries' populations.[28] Nevertheless, the participation of the LDCs in international agricultural trade is insignificant and has been declining. Their share in world agricultural exports has shrunk from 3.2 per cent in 1970–1979 to 1.9 per cent in 1980–1989 and just 0.9 per cent in 2000–2004. Their share in world imports remained at more or less at the same low level of 1.9 per cent between 1980 and 2004.

66. LDCs are considered to be the most vulnerable countries to climate change because of a high exposure to an already fragile environment and an economic structure that is already sensitive to climate impacts.[29] The LDCs lack the necessary institutional, economic and financial capacity to cope with the adverse effects of climate change. When affected by a natural disaster, the countries depend on external aid, as they do not have the necessary funds to deal with the problems themselves.

67. The LDCs also have the least capacity of all countries to adapt to climate change, lacking resources to carry out adaptation studies and to implement the strategies emerging from such studies.[30] The fact that LDCs already face severe socio-economic problems, such as water scarcity, high prevalence of diseases and food insecurity, combined with low levels of security and social stability – a number of the countries are in or have recently emerged from conflict zones – means that these societies will have minimal adaptive capacity or safety nets.

68. Climate change will place an additional burden on many LDCs. Water scarcity is predicted to increase because of lower rainfall, droughts and higher temperatures; food insecurity may increase for the same reasons; many current conflicts are caused by resource mismanagement, land distribution and scarcity exacerbated by environmental degradation, which may be intensified by climate change; prevalence of certain diseases may increase. All of the factors can combine to produce migration and social breakdown, causing a positive feedback loop.[31]

69. LDCs, SIDS and countries in Africa face similar vulnerabilities. Bangladesh, for example, has a large percentage of its population living in low-lying coastal areas and shares many vulnerabilities with SIDS. However, Bangladesh has the added problem of river flooding and potential uncertainty in future river flow due to Himalayan glacial melting, and potential changes in water availability or flooding due to changes in monsoon frequency and impact.

70. It is clear that climate change and variability, and associated increased disaster risks, will seriously hamper the ability of LDCs to achieve the MDGs, and their development in general.[32]

3. Small island developing States

71. SIDS and LDCs suffer similar economic vulnerabilities, particularly vulnerabilities to external shocks and natural disasters (of the 38 SIDS, 10 are also LDCs). With an estimated population of 50 million, SIDS are a heterogeneous group. They vary greatly in culture, topography, geological formation and economic activity, and even though they are all considered small, there is significant variation in the size of their populations and land mass. Box 1 lists the particular disadvantages that affect SIDS.

[28] FAO 2007.
[29] AR4, Synthesis Report; Stern, 2007.
[30] Huq et al., 2003.
[31] AR4, Synthesis Report, chapter 9.
[32] AR4, Synthesis Report, chapter 9.

Box 1. Characteristics that increase vulnerability of small island developing States

- Small physical size
- Limited natural resources
- Relative isolation
- Small, undiversified economies that are highly sensitive to external shocks
- High exposure to natural hazards and other extreme events
- Inordinate pressures on coastal and marine ecosystems
- Rapidly growing populations with high densities
- Poorly developed infrastructure
- High transportation and communication costs
- Limited access to funds, human resources and skills

72. Many islands are a maximum of a few metres above sea level, and most of the population of island States lives by the coast. These same characteristics limit the capacity of SIDS to adapt to the adverse effects of climate change. At the 1992 United Nations Conference on Environment and Development, SIDS were singled out as requiring special consideration.

73. Many small island States already experience the effects of variations in oceanic and atmospheric conditions. As a result, the most significant and more immediate consequences of climate change are likely to be related to changes in rainfall regimes, soil moisture, prevailing winds (speed and direction), short-term variations in regional and local sea levels, and patterns of wave action.[33] Tourism, which is a major industry in many islands, is likely to face severe disruption, and may also be vulnerable to emission reduction policies aimed at the travel sector.

74. Over the last two decades, the share of SIDS in the global merchandise trade diminished by half (from 0.4 per cent in 1980 to 0.2 per cent in 2003), while their share of global trade in services remained stable (0.7 per cent). SIDS are estimated to be 34 per cent more vulnerable economically than other developing countries, partly for the following reasons: agricultural production in SIDS, notably as a result of their exposure to natural disasters, has been 31 per cent more unstable than that of other developing countries, and their exports of goods and services have been 10 per cent more unstable.[34]

75. The fact that most island countries have fragile agriculture-based economies and depend heavily on their natural environment is also a key reason for their vulnerability to the impacts of extreme weather events. SIDS are located mainly in tropical and subtropical oceans, and their climate is influenced strongly by ocean–atmosphere interactions that often manifest themselves in extreme weather events such as hurricanes and cyclones. In the Pacific islands region, cyclones accounted for 76 per cent of the reported disasters in 1950–2004, and the average cost relating to damage caused per cyclone was USD 75.7 million in 2004 United States dollars. The 2004 Caribbean hurricane season alone caused damages estimated at USD 2.2 billion in only four countries: the Bahamas, Grenada, Jamaica and the Dominican Republic.[35] In the Pacific, the pattern of impacts of natural disasters is similar to that of other subregions. Wave surges, wind storms and floods cause the greatest loss of life.

76. Disasters often cause great social and economic devastation. The impacts of these events can set back the development process by years, by forcing the redirection of capital that would otherwise have

[33] Tompkins et al., 2005.

[34] Based on economic vulnerability data from the Report of the Committee for Development Policy on the eighth session (20–24 March 2006), *Overcoming economic vulnerability and creating employment,* United Nations, New York. See also <http://www.unctad.org/Templates/Page.asp?intItemID=3620&lang=1>.

[35] UNFCCC, 2007.

been used for development. There is often no or inadequate distinct governmental budget to fund immediate relief operations for victims. Frequently, governments are compelled to depend upon non-government agencies and external aid to assist in emergency relief operations, and on foreign donors to assist victims.

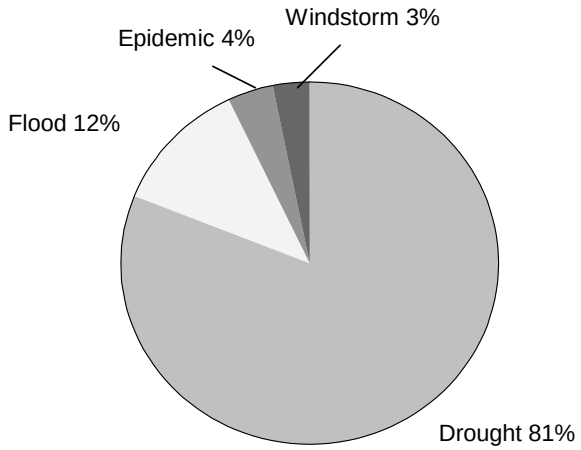
77. A striking example of the vulnerability of small island States to natural hazards occurred in 2004, when Hurricane Ivan, the most powerful hurricane in the Caribbean region in 10 years, hit Grenada. This caused the deaths of 39 people, the destruction of 90 per cent of homes and damage of USD 815 million – in excess of 200 per cent of the country's GDP.[36] The economy, which was expected to grow at 4.7 per cent before the hurricane struck, contracted by 3 per cent.

4. Countries in Africa

78. In Africa, as in other regions, a complex combination of socio-economic, political, cultural and environmental factors act and interact to define vulnerability to climate change.[37] People are affected by a number of different types of disasters (figure 2).

79. Thirty-two African countries are classified as LDCs,[38] and exhibit the attendant vulnerabilities to climate change. Many are particularly vulnerable because of multiple stresses and low adaptive capacity. Sudan, Somalia and Chad, for example, are either in or near a state of conflict, which could potentially be exacerbated by climate change.

Figure 2. Types of disaster to affect people in Africa, 1980–2006
(percentage of all people reported affected by disaster)



Source: PreventionWeb. *Africa – Data and Statistics.* Available at: <http://www.preventionweb.net/english/countries/statistics/index_region.php?rid=1>.

80. Water is often scarce in Africa – 25 per cent of the total African population experiences high water stress linked to climate. It is uncertain to what extent climate change will alter precipitation in different regions. Currently, drought affects more people, approximately 700,000 per annum, in sub-Saharan Africa than any other hazard, costing the region over USD 9 million per year.[39] In 2007, there was widespread flooding across the north of the continent – all countries from Senegal in the west

[36] Stewart, 2004.
[37] AR4, Synthesis Report, chapter 9.
[38] See paragraph 64 above.
[39] ISDR, 2007a.

to Ethiopia in the east were affected. At the same time, several seasons of failed rains led to chronic drought conditions in the Horn of Africa, the greatest impact being felt in Djibouti. With one third of the population of Africa living in drought-prone areas, several million people regularly suffer impacts of droughts and floods, exacerbated by health problems such as diarrhoea, cholera and malaria.

81. Most African economies are more reliant on agriculture than countries in other regions of the world. Agriculture accounts for approximately 21 per cent of GDP on average, but is highly reliant on seasonal rainfall. The precise link between land-use change, climate stress and feedbacks is uncertain, as is the contribution of climate change to food insecurity. Overstretched ecosystems, often relied on by people for essential services, are also highly vulnerable.

82. Africa is the continent with the poorest level of human health. Sub-Saharan Africa has the highest prevalence of HIV/AIDS in the world, for example, and it has been estimated that malaria causes a reduction in growth by 1.3 per cent per year for most affected African countries. Poor health is caused by poor nutrition, lack of access to clean drinking water and socio-economic factors such as poor healthcare. Although the link between diseases and changes in climate is complex, there are some predictable outcomes; for example, vector-borne diseases are likely to become prevalent in new areas, such as the highlands of Kenya. This is likely to be particularly harmful, as people in these areas will not have developed any resistance to the diseases.

F. Creating a framework for managing climate risk

83. Managing the additional burden of climate change risks will involve loss prevention and financial measures to spread costs. Examples of loss prevention include coastal setbacks to deal with tidal surge, resilient building practices and improved strains of crops. Spreading financial risk includes formal and informal responses to expected losses such as self-insurance, for example precautionary savings in financial or other assets, social networks and formal insurance. For policymakers, the challenge is how to encourage citizens and firms to invest in risk-reducing measures and how to integrate these risks into development assistance to improve effectiveness. Involving the insurers of extreme weather events in the development and execution of strategies that contribute to sustainable development would enhance disaster resilience, reduce the magnitude of losses, and thus help increase insurers' willingness to establish, maintain and expand a presence in developing countries.

84. Developing countries have been risk-takers when it comes to natural hazards, and have primarily depended on disaster response aid, budget diversions, government safety nets, sale of personal assets and loans from affected people's relatives and friends. The 2007/2008 *UNDP Human Development Report* noted that donor and recipient countries are often more willing to provide and receive relief aid than to invest in disaster reduction activities.[40] Disaster is still sometimes treated as an unexpected interruption to development rather than as an expected risk.

85. Modelling hazard risks in macroeconomic projections and estimating changes in real per capita income have shown that climate-related catastrophes can slow or stall the reduction of poverty. Most of the MDGs cover areas that are closely linked to vulnerability to natural hazards. In order for countries to meet poverty reduction objectives, it is necessary that potential hazard risks are determined and risk management approaches taken into account while designing poverty reduction strategies and development plans.

86. In many countries, there is a need to build capacity to raise awareness of the future risks and immediate benefits that can be derived from risk-transfer mechanisms. Further, where climate change is not mainstreamed into national development planning, there is high risk of maladaptive policies and other practices that actually increase vulnerability, such as promoting development and even rebuilding

[40] UNDP, 2007b.

in risk-prone locations. If this trend proceeds too far, the risk of losses becomes so great that it is uninsurable.

87. Insurance and other ex ante risk financing mechanisms could play an important role in disaster risk reduction and adaptation to climate change. Risk-transfer options for low-income households and businesses include microinsurance schemes. These provide accessible and affordable cover for deaths, health expenses and loss of small-scale assets, livestock and crops in the event of a flood, drought, typhoon or other natural disaster. In a review of microinsurance for natural disaster risks in developing countries, it was found that only 1 per cent and 3 per cent of households and businesses, respectively, have insurance coverage against catastrophe risks, compared with 30 per cent in high-income countries.[41]

88. When it provides coverage for potential loss, the insurance industry is concerned that there might be increased risk-taking behaviour on the part of the insured; that is, both private and public sectors may take less precaution if their assets or livelihoods are insured. This is described as moral hazard. Moral hazard does not mean that people intentionally cause losses; they simply take fewer measures to prevent misfortune. If the problem of moral hazard is too great, risks will become uninsurable. This reinforces the need for sound physical risk management to underpin any financial risk transfer.

III. Hazards, assets and vulnerability

A. Introduction

89. This chapter highlights hazards and assets, including intangible assets (for example human life), and the vulnerability of those assets to the direct impacts of climate change. It also briefly investigates the magnitude of historical losses from natural disasters and looks at the potential losses taking into account the additional burden of climate change, including the cause and the physical and temporal scale.

90. Vulnerability to climate change hazards can be reduced to a certain extent by measures to promote resilience, adaptation and disaster risk reduction. This still leaves residual hazards caused by climate change, in addition to that which societies would have experienced from natural climate variability.

91. To manage climate change hazards, a toolkit of approaches can be used, including risk reduction measures, resilience building, risk pooling and risk transfer. The first two are dealt with extensively in the technical paper on integrating risk management and disaster reduction into national policy and programmes.[42] Risk pooling requires the facilitation of access to insurance-type structures for the most vulnerable. Examples of this are the Caribbean Catastrophe Risk Insurance Facility at the country level, and microinsurance on an individual level (see chapter IV). Risk transfer requires the establishment of new mechanisms whereby the extra risks to the vulnerable caused by climate change are spread more widely.

92. In addition to humanitarian motives, there are strong socio-economic reasons for developed countries to participate in new insurance mechanisms. If not intercepted, climate impacts could lead to a downward socio-economic and humanitarian spiral, which could result in social collapse in vulnerable countries. With increased globalization of economic and social activities, this could spread to other areas through economic and societal interdependence and migration, which would end in even higher costs (using the term broadly to include economic, social and humanitarian) for developed countries. This could be partially avoided through the use of targeted ex ante risk-transfer mechanisms, if the risk-adjusted cost of this mechanism is less than the cost of not instituting such measures.

93. Climate change hazards, assets and vulnerability are described in this chapter as follows:

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[41] Mechler et al., 2006.
[42] FCCC/TP/2008/4.

(a) Section B describes how climate change will affect people and society through a change in the magnitude of hazards;

(b) Section C details how assets are affected by these hazards;

(c) The extent of damage to these assets will be determined by vulnerability, which is described in section D;

(d) Section E outlines the mechanisms that could potentially be used to transfer or pool the risks to those assets;

(e) Section F estimates the global order of magnitude of damage.

B. Types of hazard caused by climate change

94. Even without climate change, many developing countries face frequent losses from natural perils – for example, many African countries face regular droughts, and Caribbean countries face regular windstorms. This section outlines the hazards caused or exacerbated by anthropogenic climate change.

95. These hazards are grouped into three broad categories. The first are hazards that happen anyway, but climate change may change the frequency, severity and/or location. These are termed acute, as the hazards tend to be of a short time frame[43] and high severity. The second category are hazards which are caused entirely by anthropogenic climate change and are termed chronic because the impact is gradual. The third category are second order hazards that are caused by the impact of the changing climate on human or natural systems (table 2).

96. This categorization broadly reflects the three kinds of traditional insurance mechanisms: life, non-life[44] and health insurance. Life insurance is developed for a risk which is long-term and inevitable, non-life insurance is usually for short-term rare events (policies tend to be of a one-year duration), and health insurance has characteristics of both life and non-life insurance. The different hazard characteristics require different mechanisms; non-life insurance is a risk pooling vehicle for short-term contracts, and the level of capital required is much less than the total exposed risk (as there is a low probability that all of the policies will claim at the same time). However, chronic risks require the long-term build up of funds to pay the inevitable claim and are in many ways a form of saving.

Table 2. Climatic hazards, by type

Acute	Chronic	Second order	Consequential losses
• Windstorm • Storm surge • Flood • Drought • Fire • Heatwave	• Sea level rise • Ocean acidity • Changes in precipitation • Melting glaciers and permafrost • Temperature rise	• Disease • Climate-related extinctions and alien species invasion • Reduction in access to water • Changes in commodity prices, delays or cessation of unrelated activity	Direct climate hazards could give rise to multiple consequential losses, for example economic losses, social breakdown, worse health outcomes and forced migration

[43] In the context of climate change, a drought, for example, could last for a few years, but the term 'acute' is used in contrast to a permanent change in climate which is happening over a longer time period.

[44] Also referred to as general insurance or property and casualty insurance.

1. Acute hazards

97. **Wind storms** – there has been little apparent variation in the number of tropical cyclones, but there does appear to be an increase in the average intensity and the frequency in certain regions (for example the North Atlantic) and in the proportion of storms reaching a higher intensity.[45] However, even if the frequency and magnitude of storms were to remain at historic levels, damage from storms is likely to increase because of rising sea levels and other climate-related vulnerabilities (for example damage to coral due to increased temperatures and ocean acidity). Apart from direct wind damage, wind storms are usually accompanied by storm surges, as well as inland flooding and mudslides. If storm intensity does increase, this will magnify damage; for example a 5 per cent increase in wind speed is estimated to increase damage by 35 per cent.[46]

98. **Drought** – rainfall patterns are predicted to change as a result of climate change, so that some countries and regions will receive more rain and some less, the latter being more prone to drought. Drought can cause irreparable damage to food crops.[47] Lower than expected rainfall in a given year could be alleviated by an insurance payout, which could reduce many of the negative effects of drought such as malnutrition or loss of livelihood. However, such payouts will not suffice to meet a permanent change of climate, which could require a change in farming practice, for example.

99. **Fire** – climate change may cause changes in rainfall patterns, length of growing season and incidence of pathogens. This will affect the incidence and severity of wild-fire, which can lead to pervasive smog and the destruction of forests, property and crops. Predictions at local level are still imprecise.[48]

100. **Storm surge** – caused by offshore winds pushing water ahead of the storm. The impact will be greatly magnified through rising sea levels, and possibly increased storm intensity. Estimates suggest that by 2080 there could be a fivefold increase in the number of people affected by floods due to storm surge in a typical year.[49] In practice, it is not practical to discriminate storm surge from cyclone, and even flood, because damage cannot be readily apportioned.[50]

101. **Flooding** – caused by heavy rainfall, rapid thawing and potential glacial melt. Evidence shows that there is an increase globally in extensive floods.[51] Again, this could be exacerbated if forests are reduced by temperature increases, drought and fire, since run-off would be faster.

102. **Heatwaves** – exceptionally high summer temperatures can lead to health problems and premature deaths,[52] as well as damage to infrastructure. The incidence is likely to increase with global warming.

2. Chronic hazards

103. **Sea level rise** – the AR4 suggests that sea levels are expected to rise by between 18 and 59 cm by 2100, although this is unlikely to be uniform. There is also a risk that rapidly melting ice from Greenland and Antarctica could accelerate the rise above the higher level, although this was not modelled in the report.[53] Subsequent research suggests that positive feedbacks and non-linear melting of the Greenland and West Antarctic ice sheets could result in higher sea level rises: up to 4 metres by the end

[45] Emmanuel, 2005 and AR4, section 1.3.8.3.
[46] FIELD/UNDP, 2003.
[47] AR4, Synthesis Report, section 1.3.2.
[48] Bachelet et al., 2007.
[49] Nicholls et al., 1999.
[50] AR4, Synthesis Report, section 1.3.3.3.
[51] AR4, Synthesis Report, section 1.3.8.1.
[52] Possibly up to 70,000 people died as a result of the European heatwave in 2003 (Dlugolecki, 2007).
[53] AR4, WGII.

of the century in one source,[54] or 2 metres in a second.[55] This makes sea level rise both a chronic and an acute hazard – according to the IPCC view, there is almost certain to be a gradual increase in sea level rise. However, there is a non-negligible probability of relatively rapid ice sheet collapse, which would cause considerable non-linear jumps in sea level rise.

104. Under the IPCC scenarios, indirect factors are likely to outweigh direct land loss; these include erosion and damage to coastal infrastructure, salinization of water supplies, damage to sewage treatment systems and loss of ecosystems.[56] In turn, this is likely to lead to accelerated loss of agriculture (due to land loss, soil salinization and reduced water availability) and increased vulnerability to wave and storm damage, which, combined with reduced rainfall and higher temperatures, could result in water shortages in coastal areas. Sea level rise could also lead to a dramatic reduction in land value in what are currently thought of as prime locations, because the land will become uninsurable.[57]

105. **Temperature rise** – seasonal surface air temperatures are predicted to rise by approximately 1.1–6.4 °C by the end of the century, with an increase in frequency of extreme temperatures.[58] This could damage marine life and require changes in agricultural practice. Damage to coral reefs, which act as natural storm-breaks, means that tropical coastal areas will become more prone to sea surges. Temperature rises can make people more susceptible to diseases such as diarrhoea and dengue fever, as well as increasing the risk of diseases carried by insects and vermin. Higher temperatures could make some destinations less attractive for tourists. Increasing evidence is emerging of the possibility of relatively abrupt non-linear changes in temperature due to positive feedback effects.

106. **Precipitation levels** – these are likely to change but could increase or decrease depending on the region. Heavy precipitation events are likely to increase.[59] Low rainfalls lead to water scarcity and increased risk of drought. This could destroy natural biodiversity and make current agricultural practices unsustainable. High or concentrated rainfall could lead to flooding.

107. **Ocean acidity –** the increasing carbon dioxide concentration in the atmosphere means that increasing levels of carbon dioxide are adsorbed by the oceans, leading to increasing ocean acidity levels. This may further damage coral reefs and other marine life. The increased concentration of carbon dioxide may lead to reduced calcification of the reefs, destroying the natural protection they afford, and in turn damaging biodiversity and affecting tourism and fisheries.[60]

108. **Melting glaciers and permafrost –** Increased temperatures in Alpine and Arctic regions will lead to melting glaciers, altering the environment of these regions. It could also cause river flooding followed by reduced river flows. A major reduction in area covered by glaciers could lead to an 'albedo flip', where heat-reflecting ice-covered regions become heat-absorbing land or sea, increasing global warming. The melting of glaciers could be non-linear, that is, there may be acute short-time-frame, high-impact flood and droughts.[61]

109. Similarly, melting permafrost could destroy infrastructure and require a change in agricultural practice. It could also lead to positive feedback effects in global temperatures through the release of methane.

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[54] Hansen, 2007.
[55] Pfeffer et al., 2008.
[56] Gommes et al., 1998.
[57] As has happened in some parts of Bermuda (Muir-Wood, 2005).
[58] AR4, WGII.
[59] AR4, WGII.
[60] Tompkins et al., 2005.
[61] AR4, Synthesis Report, section 1.3.1.

3. Second-order hazards

110. These are direct consequences of climate change, but the hazards result from the direct impact of climate change on a socio-economic or an ecological system. Possibly one of the greatest hazards is the increased impact on human health. Human health is affected by many socio-economic and environmental factors, such as nutrition, poverty and access to medicine. Climate change could alter the prevalence of diseases in certain regions, leading to, for example, increased malnutrition, diarrhoeal disease and cardio-respiratory diseases (due to higher concentrations of ground-level ozone), and the altered spatial distribution of some infectious disease vectors. Climate change could also affect access to water and nutrition, which will have impacts on human health. Taking vector-borne diseases as an example, a changing climate may result in diseases such as malaria occurring in an area where they previously had not (for example the Kenyan Highlands). This is as a direct result of climate change, but it is a second-order effect. The first-order effect is an increase in temperature (among other factors), but the malaria hazard is caused by the second-order effect of the increase in temperature on the ecosystem, which increases the prevalence of malaria.[62]

111. Climate change is also likely to alter the ability of animal and plant species to live in certain regions. This means that existing species, which may be relied upon by the local population, could die out or be replaced by alien species.[63]

112. In summary, the impact of climate change is magnified by the interaction of different hazards, for example, sea level rise combined with weakened coral could magnify the impact of sea surges. The latest scientific evidence suggests that hazards which are apparently chronic, that is, long-term and inevitable, could behave more like acute hazards – where the onset could be rapid and unpredictable.

4. Consequential losses

113. There is the possibility of third-order or higher impacts as losses from one asset cascade into other assets, for example an outbreak of malaria might cause an enterprise to become insolvent (for example through lack of staff leading to non-fulfilment of contracts), which would cause a further loss to that enterprise's customers, financiers and other stakeholders. The malaria outbreak is defined as a second-order hazard – climate change related temperature rise is not the direct hazard in this situation, but the effect on a natural system leading to the increased prevalence of malaria; other losses are indirect consequences. The cascading effect on assets is dealt with further in chapter III C.

114. Potential effects of consequential losses abound; for example, extreme weather events may disrupt energy supplies, or divert government resources to reconstruction away from 'business as usual' activities.

5. Risk and uncertainty

115. Risk refers to the probability distribution of an event, where the probability distribution is known or can be estimated, usually from past data. For example, insurance companies normally have details of historic losses from which they can model future claims. In contrast, uncertainty refers to cases where the distribution is not known.

116. Climate change is likely to result in a number of uncertainties. In chapter III B, it is noted that climate change will affect the frequency and severity of many acute hazards – events that happen anyway but are exacerbated by climate change. However, the new distribution of these events is unlikely to be knowable with any degree of certainty. This is particularly the case with extreme events; for example, a particularly severe hurricane could be modelled as a 1 in 100 year event. Risk modelling companies will have researched data going back for a considerable time, and can estimate the damage caused by such an

[62] AR4, Synthesis Report, chapter 8.
[63] AR4, Synthesis Report, chapter 4.

event, but this estimate will still rely on sketchy data because there have not been many such events since records began. Climate change is estimated to increase the frequency and severity of hurricanes in the North Atlantic.[64] However, at the moment the new distribution cannot be accurately estimated. Similarly, current science does not allow local estimates of acute risk to be carried out with any degree of confidence. For example, the IPCC states that "dynamical processes related to ice flow not included in current models but suggested by recent observations could increase the vulnerability of the ice sheets to warming, increasing future sea level rise. Understanding of these processes is limited and there is no consensus on their magnitude."[65]

117. This has profound implications for designing risk-transfer mechanisms. Private-sector insurance will succeed only if premiums can be calculated. A risk premium P is:

P = probability of loss * severity of event

118. A premium is then calculated from the above equation by loading P for expenses and profit, and adjusting for market conditions.

119. In addition, a private insurer needs to hold capital, based on reducing the probability of ruin below a defined level. If the insurer cannot estimate the probability distribution of loss, he may not be willing to offer insurance (that is not to say that insurance products have not been sold where the underlying loss distribution is not known, but these products are not sustainable in the long run). For example, if the 1 in 100 year hurricane described above is now a 1 in 10 year event, then the risk premium would be 10 times as large.

120. The implication is that private insurance alone will not be viable for any climate-related hazard where the underlying loss frequency and severity distributions cannot be estimated. Private-sector insurance will be viable only if the uncertainty is backed by the public sector to remove the uncertainty, or climate models improve to an extent where the risk premium can be calculated with a degree of confidence. A practical solution during such a period of uncertainty could be to restrict the aggregate amount of risk that is transferred under a private market system, with the remainder of the risk being retained by the Parties at risk or the public sector.

121. Climate change also raises another area of uncertainty: increases in temperature at the higher end of the IPCC predictions are outside the range of human experience, and the risks caused by this increase are unknown. Therefore it is not possible to map a complete range of hazards for 'unknown' risks, which means that designing an insurance vehicle is challenging.

C. Effect on assets

122. This section addresses the impact of the hazards described above on assets of developing countries. Although the hazards have been listed separately, the combined effects are inevitably greater than the sum of the parts. It would be impossible to fully list the assets that could be affected by climate change, but a select list is shown in table 3. The table lists the direct hazards that could affect the assets, and the indirect losses that could affect the assets as a result of a direct hazard affecting another asset. For example, a change in precipitation levels would affect the water supply (direct hazard) which would in turn have an impact on human health (indirect hazard).

[64] AR4, WGII.
[65] AR4, WGII.

Table 3. Assets affected by climate change

Asset	Direct hazard	Indirect loss
Human		
Human life	Wind storm, storm surge, fire, drought, heatwave, flood	Lack of access to water, disease, food security, social breakdown, damage to infrastructure
Health	Drought, heatwave, fire	Lack of access to water, disease, food security, social breakdown, damage to infrastructure
Physical		
Property	Windstorm, storm surge, fire, flood	Social breakdown
Infrastructure	Windstorm, storm surge, fire, heatwave, flood, sea level rise, melting glaciers and permafrost	Second order effects: lack of access to supplies, damage to ecosystems (e.g. damage to forests, which can lead to flooding), etc.
Water supply	Drought, changes in precipitation, temperature rise, melting glaciers	Social breakdown, damage to infrastructure and ecosystems
Socio-economic		
Agriculture	Temperature rise, changes in precipitation, windstorm, storm surge, fire, drought, flood, sea level rise, melting glaciers and permafrost	Lack of access to water, labour (owing to disease or social breakdown), damage to infrastructure
Fisheries	Ocean acidity, changes in precipitation, temperature rise	Pollution caused by other natural disasters
Cultural capital	Temperature rise, changes in precipitation, windstorm, storm surge, fire, drought, flood, sea level rise, melting glaciers and permafrost	Lack of access to water, disease, food security, social breakdown, damage to infrastructure
Government	Temperature rise, changes in precipitation, ocean acidity, windstorm, storm surge, fire, drought, flood, sea level rise, melting glaciers and permafrost	Food security, property damage, social breakdown, damage to infrastructure, second order effects such as commodity price rises
Tourism	Temperature rise, changes in precipitation, windstorm, ocean acidity, storm surge, fire, drought, flood, sea level rise, melting glacier and permafrost	Social effects, damage to infrastructure and ecosystems
Livelihood	Temperature rise, changes in precipitation, ocean acidity, windstorm, storm surge, fire, drought, flood, sea level rise, melting glaciers and permafrost	Food security, property damage, social breakdown, damage to infrastructure, second order effects such as commodity price rises and supply chain disruption
Environmental		
Ecosystems	Ocean acidity, changes in precipitation, temperature rise, melting glaciers and permafrost	Pollution caused by other natural disasters

123. The main risk from climate change arises from the multiple sources of hazards and the interaction between different assets that will be affected.

(a) **Human life and health** will be affected by increased temperatures leading to more vector-borne diseases and high temperatures combined with lack of water leading to dysentery. Vulnerability to diseases will be increased because of the lack of water and

reduced food security brought about by the decline in fisheries and agriculture. Natural disasters can cause loss of life, as can heatwaves;[66]

(b) **Infrastructure and property damage** will be increased owing to increased storm intensity, higher sea levels and reduced ability of ecosystems such as coral reefs and mangroves to absorb shocks;[67]

(c) **Water supply:**[68] the interaction between climate change and hydrology is highly complex, but it is likely that many regions will suffer from increased water stress;[69]

(d) **Fisheries** are likely to decline as a result of increases in temperature, increased acidity of water and coral bleaching;[70]

(e) **Agriculture** is likely to decline in certain regions owing to heat stress, changes in precipitation and soil moisture, salt water intrusion from rising sea levels, and damage from extreme weather events;[71]

(f) **Livelihood** is a combination of many of the other elements in the table; for example, a combination of agricultural losses and impacts on health would damage livelihood. Similarly, damage to fisheries, infrastructure and water supply could all affect livelihoods;

(g) **Tourism** will be affected through a combination of the above plus rising temperatures making certain areas less attractive. In addition, there is a possible policy risk as an indirect result of climate change from air travel becoming more expensive and less fashionable;[72]

(h) **Cultural capital:** some regions may become unsustainable as places to live because of the prevalence of natural climatic disasters. This could lead to a loss of communities and historic sites as people are forced to migrate, and to further disruption brought about by migration;

(i) **Government:** the ability of a government to provide normal services might be impaired by climate change. After a disaster, a government will have to divert budgets away from normal functions, such as maintaining infrastructure and providing health and education;

(j) **Ecosystems:** many people rely on ecosystem services, for example for food, energy and water. These are likely to be damaged, for example by changing temperatures and precipitation patterns.[73]

124. In summary, a wide range of assets is at risk from climate change related hazards. A common theme is that assets can be simultaneously at risk from many hazards. The impact of climate change on one asset leads to further damage to other assets, which could lead to a downward spiral with severe socio-economic consequences. For example, damage to ecosystems could lead to reduced resilience to

[66] AR4, WG II, chapter 8.
[67] AR4, Synthesis Report, chapter 7.
[68] Water supply could be thought of as an element of infrastructure, but it is kept separate because of its importance, and it is distinct from other forms of infrastructure as it relies to a large extent on the environment. For example, water supply would be seriously affected by lack of rainfall or temperature rises, whereas a road or airport will mainly be affected by natural disasters.
[69] AR4, Synthesis Report, section 3.4.
[70] AR4, Synthesis Report, section 5.4.6.
[71] AR4, Synthesis Report, chapter 5.
[72] AR4, Synthesis Report, section 7.4.2.2.3.
[73] AR4, Synthesis Report, chapter 4.

natural disasters such as floods. It could also exacerbate lack of access to water and food, which leads to malnutrition, higher pollution levels and hence worse human health outcomes. This cascade of events could result in increased vulnerability to further events, reduced cultural capital, damage to livelihoods and worse health outcomes.

D. Vulnerability

125. Vulnerability is "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity."[74]

126. A key related concept is the concept of resilience: "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change."[75] In other words, building up the resilience of a system will reduce the vulnerability.

127. The previous sections of this chapter referred to the hazards, that is, the change in frequency and severity of risk brought about by climate change, and the assets that will be impacted by those hazards. The concept of vulnerability is to a certain extent analogous to the sensitivity of assets to the hazards described.

128. A dramatic example of the importance of vulnerability was recently demonstrated during the 2008 Caribbean hurricane season – Hurricane Gustav hit both Cuba and Haiti; it caused no deaths in the former, yet caused 76 in the latter.[76] A similar pattern was repeated with other storms in the season and is typical of other years. Haiti is particularly vulnerable owing to water run-off from its largely deforested mountains and to weak political institutions resulting from a long period of civil unrest. Cuba, on the other hand, has a sophisticated advanced warning system combined with a coordinated national mobilization response.

129. Vulnerability includes three components:

(a) Exposure: this is the extent to which a system is exposed. A simple example would be that many of the hazards described above will not affect many countries – for example, sea level rise is unlikely to have much direct impact on a land-locked country such as Switzerland, whereas low-lying countries with large coastal areas, such as the Netherlands and Bangladesh, are highly exposed. This is determined by the physical location of a society;

(b) Sensitivity: this describes the damage caused by an event of a given magnitude. The example above demonstrated that Cuba is more resilient to hurricanes than Haiti, because the former has effectively undertaken disaster preparedness whereas the latter has not. Some countries are also more or less sensitive because of their socio-economic characteristics. For example, Bermuda, as a small island, is physically exposed to hurricanes, but its economy has low sensitivity as it relies mainly on financial services, which exist in a 'virtual world' largely immune to hurricanes, unlike many small island States which rely on fishing, agriculture and tourism and can therefore be highly exposed to hurricanes;

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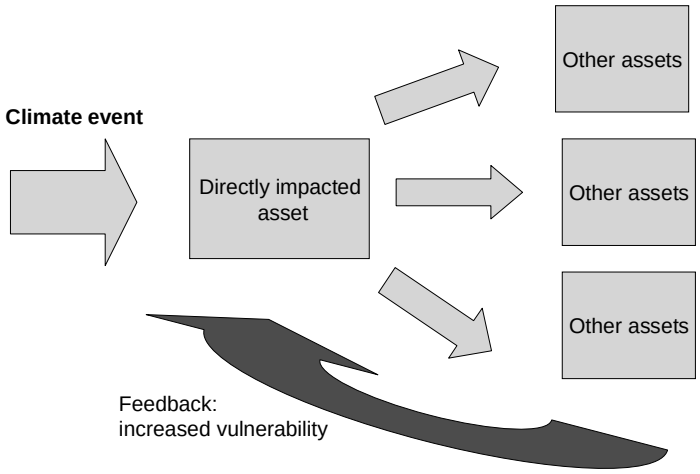
[74] AR4, Glossary.
[75] AR4, Glossary.
[76] This was the case even though wind speeds in Cuba were much higher (Associated Press, 2008). Casualties are usually adjusted upwards after the event, but the extreme discrepancy between the two countries is likely to remain.

(c) Adaptive capacity: "The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences."[77] In the case of a country or society, this depends upon its wealth, economic diversity, social institutions and geography.

130. The example of Cuba highlights that vulnerability can be actively reduced through government intervention and prioritization. Vulnerability also changes through time, as described in the UNFCCC technical paper on physical and socio-economic trends.[78] The effect on social and economic trends is complicated, but there are certain broad trends. For example, economic development reduces vulnerability in the main but it has also led to high values of assets in high-risk areas. Economic growth in combination with increasing populations has put an increasing strain on the environment, making ecosystems more vulnerable and leading to feedbacks on vulnerabilities (for example, deforestation increases flooding). Urbanization trends can act both ways; people living in cities are less exposed to the direct impact of climate change, but the growth of mega-cities has led to a large concentration of risk (for example Delhi, India, which is prone to major floods, has increased in population from 2 million in 1950 to over 16 million in 2008).

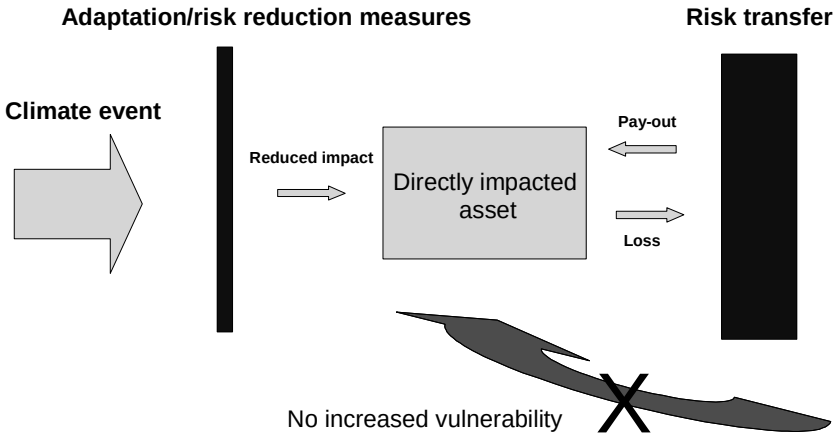
131. An ex ante risk-transfer mechanism can reduce the cascading effect caused by climate-related natural disasters and hence reduce vulnerability. This is illustrated by figures 3 and 4.

Figure 3. How a climate event causes increased vulnerability



[77] AR3, WGII.
[78] FCCC/TP/2008/3.

Figure 4. How adaptation and risk-transfer mechanisms reduce vulnerability



132. Risk-transfer mechanisms can compensate victims for loss of the directly affected asset, which can be replaced, and can also preserve indirect assets. For example, parametric crop insurance provides a cash injection after a period of low rainfall. This means that farmers can maintain themselves until the next crop cycle. In the absence of this insurance, the farmer can be forced to sell livestock and migrate to avoid famine, thus destroying his livelihood.[79]

E. Matching risk-transfer mechanisms with assets to reduce vulnerability

133. The previous sections of this chapter assessed the hazards that will be caused or exacerbated by climate change, as well as the impact of those hazards on assets, and established that risk-transfer mechanisms can effectively reduce vulnerability. This section matches existing risk-transfer mechanisms with assets. This is outlined in table 4.

134. Current risk-transfer mechanisms in developing countries are discussed more fully in chapters IV (insurance) and VI (non-insurance instruments). Table 4 shows that there are many examples of insurance mechanisms that operate in the private sector in developed countries; some of these mechanisms, for example health and property insurance, have been trialled successfully in developing countries. Agricultural insurance (e.g. yield-based cover for crops) has been generally unsuccessful in developed and developing countries owing to moral hazard and political involvement, but parametric insurance products have been successful.[80] Similarly, a pilot insurance scheme for governments has been set up in the Caribbean (Caribbean Catastrophe Risk Insurance Facility (CCRIF)).

135. However, problems to setting up risk-transfer schemes remain, where:

(a) There is a large concentration of risk: this is where many policies are at risk from the same event. This is known as catastrophe insurance, and can be problematic, often requiring government involvement;

(b) Ownership is difficult to establish: where establishing ownership is non-trivial, concerning, for example, fisheries, ecosystems or water supply, insurance becomes problematic;

(c) Damage is difficult to quantify: it is difficult to assess the financial value of damage to livelihoods and cultural capital, which makes risk-transfer mechanisms problematic.

[79] World Bank, 2005.
[80] World Bank, 2005.

Parametric insurance is possible, but this still leaves a large amount of basis risk, where the payout does not match the loss.

136. These theoretical limitations are in addition to the practical problems of insurance in developing markets, both from the supply side, with problems such as lack of reliable data and financial infrastructure, and from the demand side, because of the cost of insurance and cultural and financial sophistication issues.

Table 4. Potential risk-transfer mechanisms

Asset	Potential risk transfer mechanism	Current status
Human		
Human life	Life insurance, social insurance	A life insurance industry is well established in many countries. Microinsurance is well established in some developing countries, especially India. Many governments provide limited payouts on death.
Health	Private health insurance, social insurance	Health insurance and social insurance are long established. Microinsurance provides limited health cover in many poorer countries.
Physical		
Property	Property insurance, public-sector disaster facility, business interruption insurance	Property insurance is long established in most developed countries and some developing countries. However, catastrophes are often excluded, hence the need for public-sector disaster facilities. Smaller companies in developing countries have limited access. The poor and vulnerable are usually not serviced. Business interruption insurance is not widespread.
Infrastructure	Property insurance	Infrastructure is usually insured when privately owned, but government-owned infrastructure is often self-insured.
Water supply	Parametric insurance	No significant pilots have been carried out for water supply assets.
Socio-economic		
Agriculture	Crop insurance	Yield-based insurance is problematic in developed countries. Parametric insurance is being piloted in many developing countries.
Fisheries	None	Insuring fisheries is problematic, as damages and ownership are difficult to assess.
Cultural capital	None	Insuring cultural capital is problematic, as damage is difficult to assess.
Government	Multilateral facilities	A parametric insurance scheme has been established in the Caribbean (Caribbean Catastrophe Risk Insurance Facility).
Tourism	Property insurance, business interruption	Larger operators are often insured. Smaller companies or individuals in developing countries have limited access Business interruption is not widespread.
Livelihood, business turnover	Compensation fund, business interruption	Business interruption insurance is not widespread. Low-income and small business sectors are ignored. Parametric cover may be possible.
Environmental		
Ecosystems	Property insurance, compensation fund	Direct insurance is difficult, as damages and ownership are difficult to assess. Forestry insurance has been trialled.

F. Assessing the magnitude of losses

137. Assessing the potential scale of climate change losses is fraught with difficulty. First, there is a great deal of uncertainty as to the scale of climate change – the IPCC estimates that temperatures will increase between 1.1 and 6.4 °C by the end of the century, which is a massive range. There is a higher level of uncertainty over how this will affect second-order variables, such as rainfall and wind-storms, especially at the higher end of the range. The regional granularity of these changes is not known with any degree of certainty. Moreover, the human and socio-economic impact is subject to another layer of uncertainty.

138. The best that can be hoped to be achieved are order of magnitude calculations. The possible range of damage caused by three of the climate change related impacts – disasters arising from natural hazards, health impacts and sea level rise – are shown below.

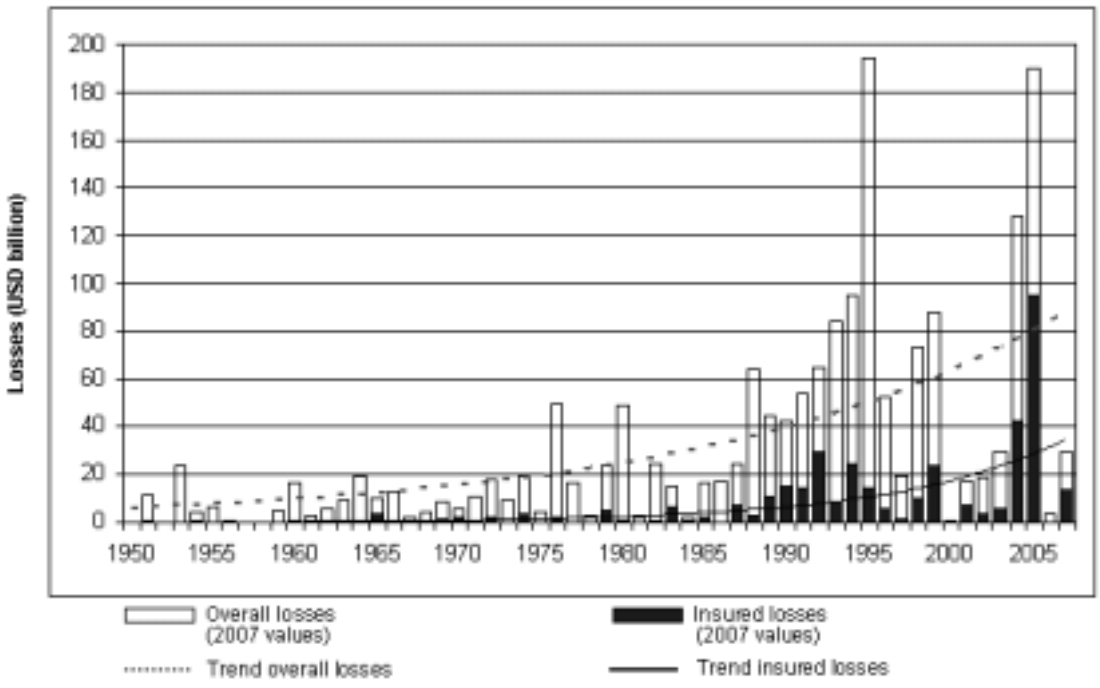
1. Disasters arising from natural hazards

139. Studies show an increasing trend of losses; for example, figure 5 shows that the average damage from natural disasters has increased over the last 20 years. The main driver for this increase is not necessarily climate change, but increases in vulnerability caused by increases in population and assets located in vulnerable areas.

140. However, studies are likely to reflect an underestimation of the actual damage, as only large losses are included in the figures and the actual losses from natural hazards could be as much as five times as high.[81] A number of estimates have been made recently as to the current level of losses from disasters arising from natural hazards.

141. However, there is no consensus even on what the current losses are in financial terms; the range is between USD 20 billion and USD 85 billion,[82] depending on what is included. None of the figures include secondary impacts such as business interruption; the actual economic loss could thus be somewhat higher.

Figure 5. Overall and insured losses from major natural disasters, 1950–2007



Source: Münchener Rückversicherungs-Gesellschaft Geo Risks Research, NatCatSERVICE.

[81] Dlugolecki, 2007.
[82] Cummins and Mahul, 2008; Mirza, 2003; Dlugolecki, 2007; Scheuren et al., 2008.

142. As discussed above, estimates of future losses are subject to even greater uncertainty. Dlugolecki (2007) estimates that in 2030 global losses will increase to USD 600–1,000 billion,[83] and, for developing countries, to USD 300–500 billion, which is three to five times today's level.

143. The Stern Review estimates that damage from extreme weather could increase to 1 per cent of GDP by the middle of the twenty-first century.[84] This represents a threefold increase in relation to the current level of damage (approximately 0.3 per cent GDP).[85]

2. Human health

144. The World Health Organization estimates that climate change is responsible for over 150,000 deaths each year through increasing incidence of diarrhoea, malaria and malnutrition, predominantly in Africa and other developing regions[86]. An increase of 1 °C in global temperature would double annual deaths from climate change to at least 300,000, which would increase to millions at higher temperature increases. This section considers dengue fever and malaria, possibly the diseases on which climate change will have the largest impact, and attempts to estimate the additional economic burden caused by climate change.

145. **Malaria**. A 2 °C rise in temperature may lead to 40–60 million more people exposed to malaria in Africa (a 9–14 per cent increase on present-day levels), increasing to 70–80 million more (16–19 per cent increase) at higher temperatures, assuming there is no change to efforts to control malaria.

146. The incidence of malaria is mostly caused by climate and the environment rather than poverty. It is estimated that malaria causes a reduction in economic growth of 1.3 per cent per annum in the worst affected countries, as it affects the ability of the country to attract foreign investment and to create an environment suitable for growth.[87]

147. Malaria is estimated to cost Africa USD 12 billion per year,[88] so an increase of 10–20 per cent would cost USD 1–2.5 billion per year. Africa represents 85 per cent of all malaria cases,[89] so that means the extra burden of malaria worldwide is USD 1.2–3 billion per year.

148. **Dengue fever**. Climate change will also increase the global population exposed to dengue fever, predominantly in the developing world; for example, a 4 °C temperature rise could result in 5–6 billion people being exposed,[90]compared with 3.5 billion people exposed if there is no change in temperature.[91] Currently, approximately 100 million people are affected with dengue fever every year;[92] assuming infection rates are the same, the increased exposure caused by climate change would mean that an extra 60 million people would be affected each year.

149. A number of studies have been carried out on the economic cost of dengue fever – estimates of cost per case range from USD 500 to USD 700.[93] These costs reflect the treatment of hospitalized cases,

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[83] In 2006 United States dollars.
[84] Stern, 2007.
[85] From figure 2.1 above.
[86] WHO, 2008.
[87] Economic growth would be 1.3 per cent per annum higher in a given country if it did not have malaria (Gallup and Sachs, 2001).
[88] Greenwood et al., 2005.
[89] WHO, 2008.
[90] Exposure means there is greater than 50 per cent chance of an epidemic based on epidemics over 20 years.
[91] Hales et al., 2002.
[92] Moore, 2007.
[93] In Panama, for example, this refers to an amount of USD 16.9 million per 32,900 cases in Panama, roughly 513 USD per person (Armien et al., 2008) while in Malaysia it amounts to $USD 700 per person (Shepard et al., 2006).

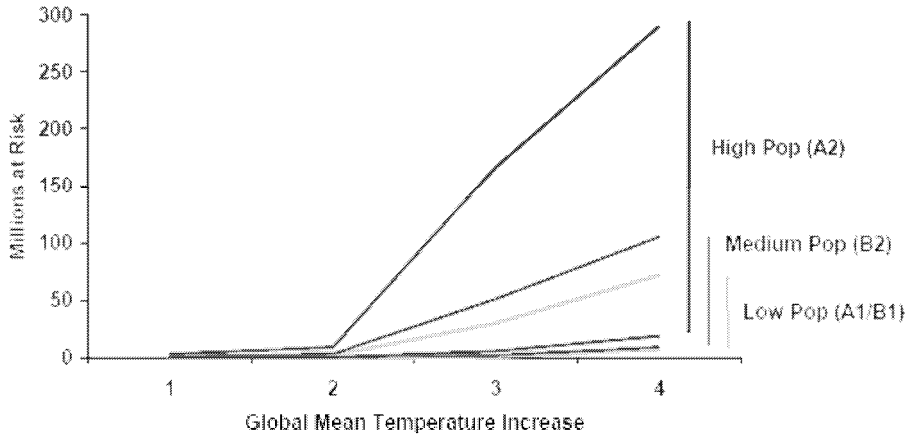
and are therefore underestimates, as they do not take into account negative externalities. If an extra 60 million people per year were to be infected, the extra cost would be USD 30–40 billion per annum. These costs could be reduced by up to 87 per cent[94] through a successful vaccination programme.

150. In summary, the increased cost from the two main diseases, malaria and dengue fever, could bring about an extra burden from healthcare and lost revenue of USD 1.2–3 billion per year and USD 30–40 billion per year, respectively. It should be noted, however, that the AR4 states that "the economic costs for estimating welfare benefits have several shortcomings. Further research is needed to estimate productivity costs."[95]

3. Sea level rise

151. Figure 6 gives an estimate of the additional number of people at risk from coastal flooding brought about by sea level rises. The range is between 7 and 300 million additional people who would be flooded each year by 3 to 4 °C of warming causing sea level rise of 20–80 cm. The wide range is due to different scenarios in estimates.

Figure 6. Additional number of people at risk from coastal flooding due to global warming



Source: Stern N. 2007. *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University Press. p.20.
Abbreviations: A2, B2 and A1/B1 reflect scenarios drawn from the IPCC special report on emissions scenarios.
Pop = population.

152. As this paper is concerned with risk-transfer mechanisms, the probability of larger non-linear effects must be considered. A 5 m rise in sea levels caused by the sudden collapse of the Greenland and West Antarctic ice sheets by the end of the century has been discussed as a serious possibility.[96] It is estimated that this would affect 5 per cent of the global population and threaten USD 2 trillion worth of GDP.[97]

153. An attempt can be made to produce an estimate of the capital lost – the insurance damage – from this loss of GDP. If it is assumed that the same proportion of developed and developing country GDP is affected, then USD 500 billion of developing country GDP is at risk.[98] However, GDP represents a flow

[94] Shepard et al., 2006.
[95] AR4, section 8.5.
[96] Hansen, 2007.
[97] Stern, 2007.
[98] Approximately 24 per cent of GDP is from the developing world. See <http://siteresources.worldbank.org/DATASTATISTICS/Resources/GNI.pdf>.

figure and not a capital value. To convert from one to the other, and assuming that the infrastructure would be replaced over 20 years, using a discount rate of 2 per cent produces estimated capital damage of USD 8 trillion. This is not an accurate figure, but it gives an order of magnitude figure for the upper range of damage.

154. The conclusion is that the cost of the loss of land from sea level rise is difficult to determine. At the lowest end of the IPCC range, the cost of defending sea level rises of 18 cm would be relatively small. However, at the upper range of possibilities – about 5 m by the end of the century – the magnitude of damage is almost unbounded.

G. Conclusions

155. The likely costs from hazards caused or exacerbated by climate change are not known with accuracy, but are likely to be considerable. These could be significantly reduced by measures to promote resilience, adaptation and disaster risk reduction; but this would still leave a residual risk, which would be felt particularly severely by the poor.

156. Ex ante risk-transfer mechanisms can provide timely and orderly injections of funds when they are required and hence reduce vulnerability to climate change. For example, a pay-out on low rainfall can mean that a farmer could survive a season of drought without a loss of livelihood.

157. There are already insurance products for climatic hazards in developed countries and pilot schemes in developing countries. These could, in principle, provide valuable risk pooling services on a large scale for developing countries, particularly for climate hazards which are short-term and acute, and where there is a spatial and temporal uncertainty of impact, such as droughts and hurricanes.

158. Pure private-sector insurance may not be viable for many climate change related hazards, as the underlying risk distribution of hazards is unknown and therefore insurance contracts cannot be priced. Public-sector involvement and/or improved knowledge could overcome this problem.

159. Even with the successful deployment of existing and new risk-transfer mechanisms, the vulnerable would still be at risk from hazards exacerbate by climate change. Owing to the increased interdependence of countries on each other, impacts in poor and vulnerable regions could cascade throughout the global economy. It could therefore be cost-effective to spread these risks more widely.

IV. Insurance mechanisms to handle climate-related risks, with particular reference to developing countries

A. Introduction

160. The previous chapters noted that the economic effects of weather hazards can be severe at the individual level, as well as for communities and entire regions, particularly in developing nations. This chapter reviews the present approaches for insuring against weather hazards:

(a) Section B puts financial risk management into context by noting the critical importance of physical risk management or loss prevention;

(b) Section C provides an overview of the insurance industry, and how mainstream insurers have been addressing climate change in developed economies;

(c) Section D describes the significant gaps in coverage in developing countries because of the major barriers to transacting insurance there;

(d) Section E discusses the recent and promising variations that have been evolved for end-consumers, including different products and distribution methods such as weather derivatives and microinsurance;

(e) Section F considers the different roles that the public and private sectors could play to establish an effective insurance system;

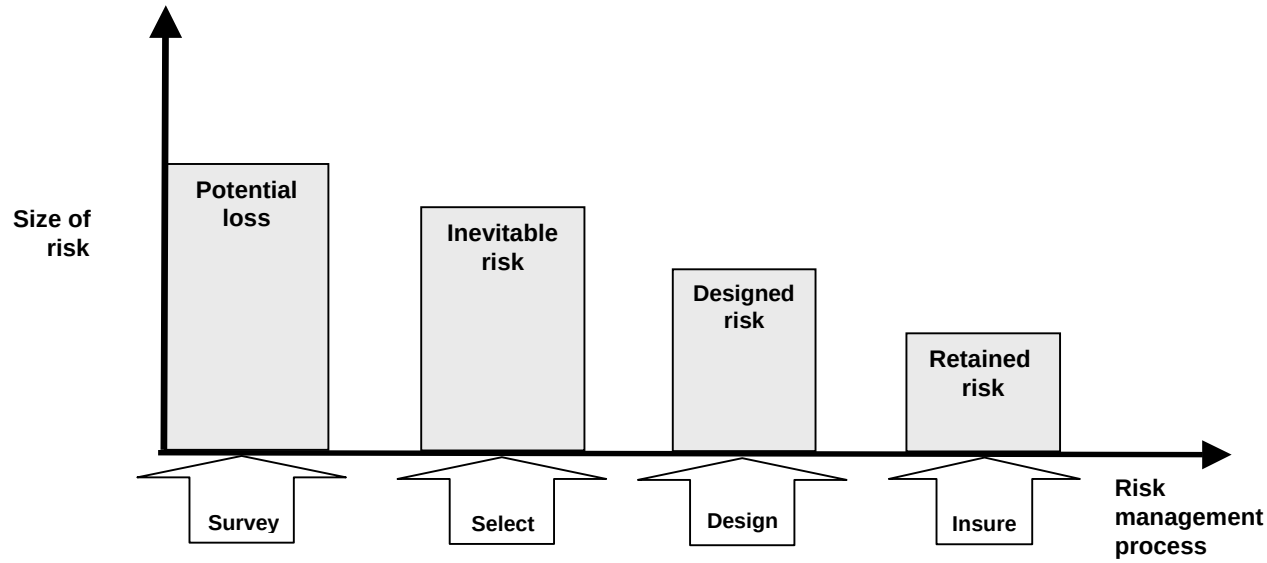
(f) Section G addresses how to scale up successful systems;

(g) Section H examines the relatively few examples of state-level insurance schemes that have appeared.

B. Non-financial approaches to risk-management

161. Transferring risk through insurance is a key component of loss prevention, but it is only the last step in a systematic risk management process. Before reaching a decision about which risks can be cost-effectively transferred, it is essential that activities are thoroughly organized to reduce risks as far as economically possible through planning to eliminate avoidable risks, and by designing resilience into systems and assets (see figure 7).

Figure 7. Insurance in the risk management process



Source: After United Nations Environment Programme Finance Initiative, Insurance Working Group. 2007. *Insuring for Sustainability: Why and How the Leaders are Doing It*. Geneva: United Nations Environment Programme. p.20.

162. Damage from climate-related disasters already threatens economic growth in many areas in various ways, and these stresses will accelerate in coming decades. Managing the impacts of climate change (e.g. through water management, disaster preparedness or land-use planning) should be integrated into national and sectoral policy at each every level of decision-making. For example, the MACCC project (Mainstreaming Adaptation to Climate Change in the Carribbean) addresses development issues in key sectors (water, agriculture, health), and develops responses at different levels. Similarly, the Asian Development Bank is integrating climate change into its grant and loan procedures (so-called climate-proofing).

163. Forward-looking policy can reduce the effects of climate change by anticipating its future risks, in order to both capitalize on opportunities and minimize harm. Conventionally, this means identifying

the planning horizons for key impact areas and sectors, developing plans and planning capability, selecting the best options and implementing them well. It also entails contingency planning to deal with impacts and responding effectively to climatic disasters. The second step is enhancing adaptive capacity. This requires various resources, including information, skills, finance, a strong regulatory framework that reflects the new climatic conditions and, in some cases, new technologies. Table 5 shows some adaptations which are already occurring, often with the involvement of the financial sector.

Table 5. Examples of adaptation

Country or region	Sector affected	Impact	Measure
Austria	Skiing	Less snow	Diversification (spas, eco-tourism)
Bangladesh	Livelihood	Sea level rise, salinization	Diversification (crops, income), water management (low-tech filters), public mobilization
South Africa	Livelihood	Drought	Capacity-building, debt relief for poor farmers
United Kingdom of Great Britain and Northern Ireland	Property	Flood	Revised planning guidelines, stronger defences, differentiated insurance terms
Cook Islands	Water	Drought, salinization	Water management, hydroponic farming; bank loans for rainwater storage facilities
Samoa	Infrastructure Property	Cyclone Cyclone	Retrofit, new design standards, relocation, grants Diversification, emigrant remittances
United States of America (New York)	Water	Climate change	Review of planning system for capital allocation
Caribbean	Infrastructure	Climate change	Caribbean Development Bank has integrated climate change into its project planning process

Source: United Nations Environment Programme Finance Initiative, Climate Change Working Group. 2006. *Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector*. Available at: <http://www.unepfi.org/fileadmin/documents/CEO_briefing_adaptation_vulnerability_2006.pdf>.

164. The question of how to adapt may be particularly critical in coastal zones: essentially whether to retreat or to defend. Wealthy nations have more chance to defend their shorelines than developing countries. In October 2004 the US Army Corps of Engineers estimated it would cost USD 1 billion over 20 years to improve the levee system for New Orleans. Following Hurricane Katrina in 2005 the cost has risen to an estimated USD 125 billion. A new harbour in Madagascar financed by the World Bank has been enlarged to allow for the possibility that ships might not be able to depart owing to worse storms than historically experienced. Tools such as geographic information systems (GIS), scenarios and cost estimation protocols have been developed to assist coastal adaptation, under the banner of integrated coastal zone management, with wide stakeholder engagement to balance competing considerations, as well as identifying long-term and short-term aims.

165. Decisions can be made on a cost–benefit basis; it is impossible to cover everything, and some losses of unique assets may be unavoidable. Adaptation can reduce impacts by a factor of 10 to 100 for often little cost. In the Caribbean, hurricane damage to infrastructure and coastal facilities typically amounts to between 15 and 40 per cent of asset value. Altering the project specifications to reduce this can cost as little as 0.1 per cent of the original investment. In the Cook Islands, one study showed that

reconfiguring run-off channels would generate a benefit–cost ratio of 280:1.[99] Even with a very infrequent occurrence, this would be economically justifiable. The high degree of uncertainty about the exact timing and strength of impacts means that flexibility through resilient infrastructure and economic diversification is essential.

C. An overview of the insurance industry

166. One of the ways in which some societies cope with the risks of extreme weather-related hazards, such as wind storms and flooding, is by pooling their risks to spread the burden of losses. In the case of formal insurance, policy-holders pay a premium into a fund, which will compensate them if they are adversely affected by an unexpected extreme event. In this way, insurance underpins sustainable economic activity by enabling the sharing and spreading of the risk of financial losses across society, and reducing the potential consequences for individuals.[100]

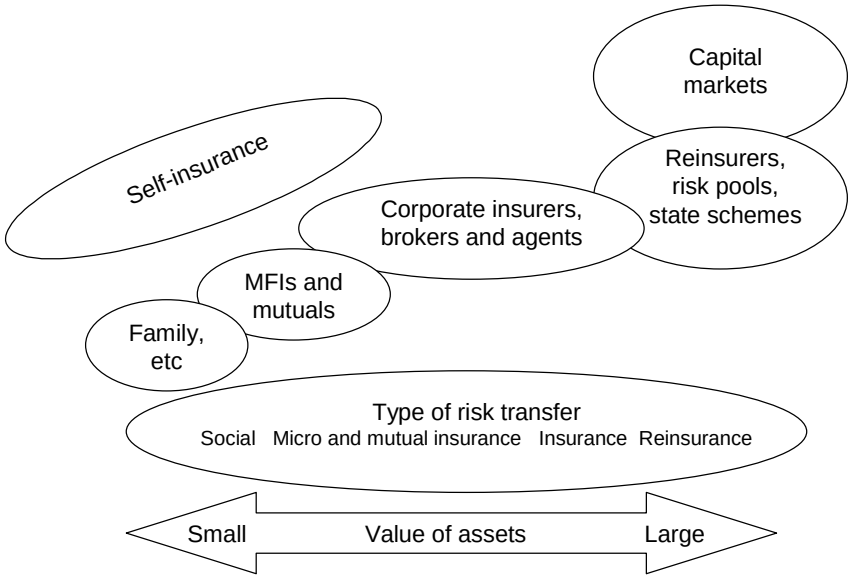
167. This section considers the current structure of the insurance industry, how insurers are dealing with climate change, and innovations in the products that are used at individual level and for state-level insurance.

1. The structure of insurance

168. For the purposes of adaptation to climate change, there is a wide range of ways in which risks can be spread and shared, including diverse ways of allocating costs. Figure 8 illustrates the various levels of insurance that exist and the principal organizations concerned. They range from informal arrangements for assistance with family, friends and neighbours, to community schemes like microinsurance and mutual insurance based on affinity groups such as communities and trades, to formal insurance where funds are collected by a profit-making third party, to reinsurance, which accepts risks that are too severe for smaller schemes or operators to retain. In some cases, insurers create their own risk pools to share such risks, or the state may accept uninsurable risks from them. Over most of the range, a significant proportion of insurance is self-insurance, where an entity retains risks and copes with external impacts by using its own financial resources (in the United States of America, as much as 50 per cent of corporate risk is self-insured, often within 'captive' subsidiary insurance companies). Sometimes (as in chapter V) informal sharing arrangements may be referred to as 'non-insurance' in the sense of not being commercial.

[99] UNEPFI, 2006.
[100] Ward et al., 2008.

Figure 8. Types of insurance-related interventions



Abbreviation: MFIs = microfinance institutions.

169. It is important to realize that there is a large number of specialist functions within the insurance industry, such as underwriting, risk assessment, risk modelling, claims adjustment, sales and marketing. Often these are concentrated in specialist function-specific firms, such as brokers, agents and risk modelling companies.

170. Intermediaries are essential in ensuring that insurance products reach the potential clients. Most insurers are too limited in resources to contact rural populations, and the villagers often do not have modern communication facilities, or are unable to use them. This role of intermediary is often played by NGOs, community-based organizations, public development banks and microfinance institutions.

2. The response of the insurance sector to climate change

171. While insurers are able in principle to adapt quickly to new risks, the uncertainty of future climate impacts has made it difficult for them to respond to this new threat.[101] As a result of climate change, demand for insurance products is expected to increase, but, on the other hand, climate change impacts could also reduce insurability.

172. Insurance can work only for risks that are insurable. The main principles of insurability are: risks have to be quantifiable, occur randomly and be many in number, so that variations in claims are smoothed out. From the client's side, the premiums have to be affordable and the contract has to perform reliably. For these reasons, insurers usually exclude from coverage losses due to flood, pollution, farming and gradual deterioration of assets, and reinsurers place limitations that may seem quite restrictive on the aggregate risk that they will accept. In practice, insurance systems differ widely between countries in their treatment of climatic risks.

173. Moral hazard and adverse selection are common barriers to a thriving insurance market. In the former, insured parties relax their risk vigilance, since insurance will now pay for any losses; in the latter, parties whose risk is inherently worse than average purchase insurance, so driving up the losses beyond the insurer's expectations.

[101] AR4, Synthesis Report.

174. Underwriting requires thorough knowledge of the risk in order to identify any systematic variations from what is usual. When the risk is being assessed, there may be opportunities for loss prevention, that is, ways in which the physical risk could be improved. For example, roof braces could be fitted against hurricanes, which would reduce the chance of losses, and also result in more favourable insurance terms for the client. Insurers prefer to apply risk-based underwriting, whereby the terms of the insurance contract are varied to suit the individual level of risk of each client, in order to balance costs between insured and insurer in a rational way, and also to avoid cross-subsidies within the insurance risk pool. Finally, the type of risk-transfer contract has to be determined. This entails specifying details such as how a claim is to be assessed, the duration of the contract and the variety of risks on the contract, so that both parties know exactly what losses will be covered.

175. The insurance industry has several approaches for adapting to the growing climate-related risk to property. These include raising the cost of insurance premiums, restricting or removing coverage, reinsurance and improved loss remediation.[102] Other strategies include better risk management, greater diversification, better risk and capital auditing, greater integration of insurance with other financial services, and novel instruments to transfer risks out of the insurance market into the capital markets through catastrophe risk securitizations (catastrophe bonds or cat bonds),[103] which have increased significantly in value since 2004. Insurers are routinely using GIS and computer simulations of extreme events to provide information that will be used to adjust insurance tariffs to climate-related risks.[104] A key issue is that premiums can no longer be based upon historical experience according to standard actuarial practice, but must be forward-looking because the patterns of extreme events are already shifting, although the uncertainty of future climate change is an obvious problem in making these adjustments.[105] Box 2 provides an example of an initiative in the United Kingdom of Great Britain and Northern Ireland to manage the risk associated with repeated flooding.

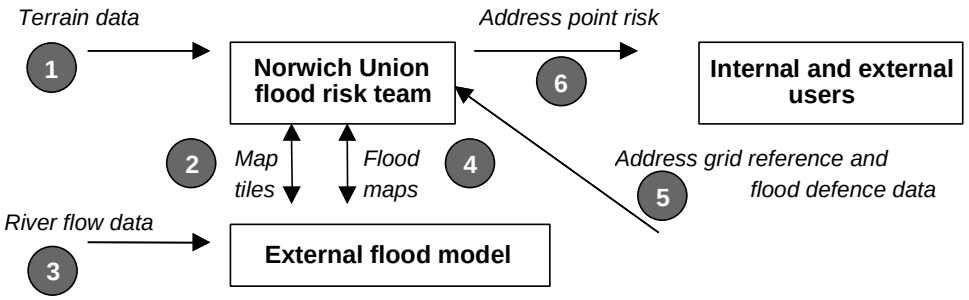
[102] AR2, WGII.
[103] European Environment Agency, 2004.
[104] Dlugolecki, 2001; Munich Re, 2004; Comité Européen des Assurances, 2006.
[105] Association of British Insurers, 2004; Loster, 2005.

Box 2. Flood mapping

The British insurer Norwich Union (NU) has carried out its own flood mapping exercise, producing the NU "Flood Risk Outlines" which is the first privately-financed map of its type. The company was motivated to undertake this effort because of the increasing losses which United Kingdom insurers were encountering from river flooding, and the growing realization that this was a risk that was being subsidized by less exposed policyholders. Potentially, competitors might start to select those better risks, leaving the insurer with substandard portfolios of risk. On the other hand, the available flood maps were known to be rather inaccurate, leaving the possibility that many homes and businesses had been misidentified as high hazard.

The diagram below shows the process of producing property-level flood risk assessment from the construction of a 'tile' or map segment, to validation and through to the completion of the risk mapping of addresses for a whole river catchment.

The process of producing property-level flood risk assessment



The height data that underpins the flood model were collected using an Interferometric Synthetic Aperture Radar (IFSAR) technique operated from a privately chartered aircraft. This uses radio waves to determine distance and ground surface characteristics for a grid with points covering the United Kingdom at intervals 5 metres apart. The ground elevation data are accurate to 1 metre for the whole country except the south-east which, owing to its high population density, was captured to a higher accuracy of 0.5 metres, and in five conurbations to 0.15 metres using laser technology.

Any errors in the elevation data can significantly influence the quality of the flood map. The model was extensively checked and corrected by NU's in-house flood risk team. These edits are based on several data sources: government agency data and flood maps, flow data and radar images, and Internet images of actual flood events.

NU commissioned external technical experts to provide river flow data and then map the extent of various floods for various severities of flood from 1 in 10 years, to the 1 in 1,000 years event.

The output is used by internal underwriting teams in pricing insurance products for commercial and domestic customers, and has been instrumental in identifying better quality risks. A version of the data is also available for external users to purchase.

176. These market signals can play a role in incentivizing adaptation by others. For example, in the Bahamas, after three major hurricanes with storm surges between 1999 and 2004, flood insurance was withdrawn in 2005 for some residential developments, ending the ability to raise bank-loan mortgages. Without a State-backed alternative, houses became abandoned as their value collapsed.[106] In response, builders are constructing new houses in the Bahamian coastal floodplain on concrete stilts, bringing some properties back into the domain of insurability.[107] Through reductions in premiums charged, insurance can encourage actions to reduce risk, such as by fitting hurricane shutters on a building or by the

[106] Woon and Rose, 2004.
[107] AR4, Synthesis Report.

construction of local flood defences.[108] In the extreme, if risk-based pricing is not permitted, the private market will withdraw, leaving the risks to be borne by property owners themselves.[109]

177. Table 6 shows some of the principal adaptive measures which the insurance industry has at its disposal. Often they are defensive, seeking to avoid loss or preserve profit, but they can often provide a basis for growth. The measures are presented according to the type of challenge that faces the insurer: regulatory risk, from interaction with licensing and other authorities; market risk, from changing conditions that affect the whole market; and business risk, which alter the competitive dynamics in the market. Where the tax base is greater, the public sector may intervene; for example, the advent of the National Flood Insurance Programme in the United States in the 1960s, the *catastrophes naturelles* legislation in France in the 1980s and hurricane insurance in Florida. Even such major public insurance schemes have faced technical insolvency: in France from subsidence claims, and in the United States from flood claims following Hurricane Katrina.

Table 6. Adaptive measures in use by insurers

	How different types of risk are addressed		
Strategy	**Measures to address regulatory risk**	**Measures to address market risk**	**Measures to address business risk**
Reduce risk	Engage with Government on flood defence funding and land zoning (UK), and building standards (Fiji, USA)	Withdraw from high-risk areas (USA) Avoid catastrophic risks such as flood (common)	Understand the sensitivity of new industries and locations (reinsurers)
Price risk correctly	Seek approval to modify prices based on risk modelling (USA)	Seasonal forecasts for hurricane risk (reinsurers) Trend allowance for climate change (rare)	Use geographical information systems to discriminate risks (UK, USA)
Transfer risk	Government back-up (France)	Reinsurance (universal)	Seek alternatives to reinsurance (brokers)
Check aggregate	Stress-test exposure by disaster scenarios (rating agencies, licensing authorities, common)	Internal capital-rationing (risk-based capital) (common)	Consider asset-liability correlation (rare)
Control loss	Defend actions that seek to expand coverage (USA)	Contingency planning, pre-event deployment (USA)	Advanced techniques for subsidence repairs (UK)
Diversify risk base	Open up new markets e.g. rainfall insurance (India)	Multi-line insurance portfolio (universal)	Mine data to exploit new markets (some reinsurers)

Source: United Nations Environment Programme Finance Initiative, Climate Change Working Group. 2006. *Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector*. Available at: <http://www.unepfi.org/fileadmin/documents/CEO_briefing_adaptation_vulnerability_2006.pdf>.
Abbreviations: UK = United Kingdom of Great Britain and Northern Ireland, USA = United States of America.
Note: Detail in parentheses indicates country or sector where strategy is applied.

Risk Pools

178. Insurance-related instruments that spread and pool risks may be important for supporting adaptation to climate-related disasters in developing countries, because they lower the inter-annual variability in the payouts.[110] Pool solutions already exist in some countries. Switzerland, for example, already has a natural perils pool, France, Norway and Spain have similar pool solutions and Japan has set

[108] AR4, , Synthesis Report.
[109] Freer, 2006; Ward et al., 2008.
[110] Linnerooth-Bayer et al., 2005

up an earthquake pool for residential buildings, which shares liability between the insurance sector and the State.

Alternative risk transfer

179. One of the interesting developments in recent years has been the emergence of alternative indexed insurance risk-transfer products to handle risks which the conventional insurance industry has avoided; for example, captive or mutual insurance companies for corporate risks, weather derivatives for non-catastrophic climatic variability, and catastrophe bonds (cat bonds) for catastrophic risks like earthquake and hurricane (box 3). Cat bonds act like reinsurance to remove the peaks or volatility of climate risks, which is a major concern for solvency and shareholder returns. The principal obstacles to greater use of the capital markets are: the higher prices; the possibility of basis risk, because the bond is triggered by objective conditions, not actual losses to the insurer; unfamiliarity; and regulatory limitations as a result of accounting rules.

Box 3. Indexed insurance contracts

Five mechanisms can be used to determine a payment from an insurance contract:

(a) *Indemnity*, a scheme based on the real verification of losses by an expert, subject to acceptance by the parties. Typically, all insurance schemes operate under this arrangement;

(b) *Parametric*, a scheme based on physical parameters that determine if the risk materialized. For hurricanes, the parameter is wind speed. If the parameter reaches the established threshold, this triggers a loss;

(c) *Modelled losses* operate like the parametric scheme. In this scheme, a mathematical model is used with a set of parameters. The parameters are the inputs of the model. If the output of the model reaches a predetermined threshold, the financial scheme pays out;

(d) *Parametric index* is mid-way between the parametric and modelled losses mechanisms. It uses a number of observations of, for example, windspeed, at different locations, weighted to reflect the amount of business at risk in the vicinity of each location;

(e) *Industry index*, an index built using sources from the insurance industry to predict the losses in the industry. Once the industry index reaches a certain threshold, it triggers a payment.

One noteworthy advantage of indexed insurance contracts is that claims management is greatly reduced, since there is no need to validate losses; they are determined by a simple objective measurement.

3. Catastrophe bonds

180. Cat bonds follow the principles behind securitizations, which have been common in the investment market for many years. They can be considered as just another form of asset, which is transferred to an investor who bears the default risk in return for a regular interest payment (the coupon). The interest rate is higher than for standard fixed interest investments to reflect the possibility of default and loss of the capital invested. The duration or tenor of a cat bond is from three to five years. This provides much greater stability than annual contracts.

181. The attraction for the investment community is that the likelihood of default on a cat bond (i.e. an insurance event) is not closely related to any other default (such as economic downturn) of fixed interest investments. This non-correlation gives diversification of the investment portfolio whilst attracting good rates of return. At the end of this period if no trigger event has occurred the funds are returned to the investor.

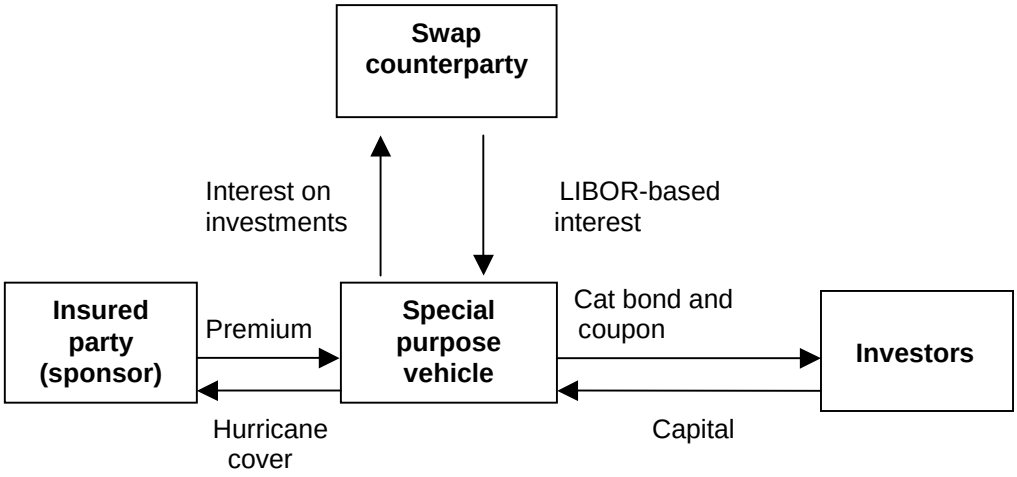
182. The key advantage of cat bonds for insurers is that they allow for the transfer of risks to a large group of investors in cases where insurance with a single counterparty might be unavailable or very

expensive. Since the funds are in trust they also provide certainty over future insurance costs, and indemnity if the specified event insured against should occur.

183. A typical cat bond structure would involve four parties, the 'sponsor' or ceding company (typically a reinsurer), the investors (large institutional buyers, who would have a cat bond as one of many investments), a special purpose vehicle or SPV (the bond issuer, typically based in a tax haven), and a swap counterparty (see figure 9).

184. The SPV is a technical device to comply with regulatory requirements. It sells securities (cat bonds) to the investors, and in return receives funds from the investor (capital), which are then invested by SPV in a trust fund. The returns on this investment are converted by the swap counterparty to a guaranteed, enhanced interest rate, based on a reference interest rate, such as the London Interbank Offered Rate, necessary for the investors.

Figure 9. Typical structure of a hurricane catastrophe bond



Abbreviation: LIBOR = London Interbank Offered Rate.

185. The SPV enters into a contract with the sponsor for the same period and value as the cat bond, to provide insurance cover against the trigger event such as a hurricane. In return the sponsor pays a premium or series of premiums to the SPV.

186. If the bond is triggered by a hurricane, the trust funds are transferred to the sponsor (constituting the claim for hurricane damage), and the bond itself is held in default, so the investors lose their capital and any further coupon payments which may be due. There are many permutations on this standard operation, particularly as to whether all of the proceeds are transferred by the trigger and whether or not payments continue after the date concerned.

D. Obstacles to the development of insurance in developing countries

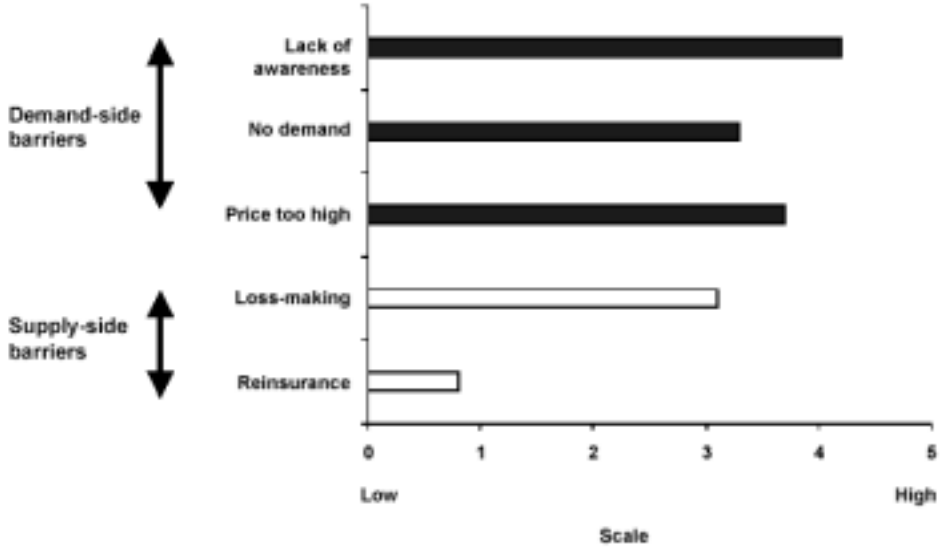
187. Currently, only 1 per cent of households and businesses in low-income countries, and 3 per cent in middle-income countries, have insurance coverage for catastrophe risks, compared with 30 per cent in high-income countries.[111]

188. Interestingly, poverty appears not to be the chief obstacle. This is confirmed in a major study of barriers to microinsurance in 38 countries.[112] Practitioners were asked to rate the importance of five

[111] Munich Re, 2005.
[112] Roth et al., 2007.

obstacles, from 0 (low) to 5 (high). Three were obstacles on the demand side, and two were on the supply side (figure 10). Lack of familiarity with insurance and lack of demand were critical obstacles; price was also a significant side barrier. On the supply side the major factor was that insurers feared that the products would be unprofitable (usually with no evidence or experience to support this view).

Figure 10. Main barriers to microinsurance



189. Table 7 summarizes the main problems in providing insurance against climatic hazards in developing countries, particularly for the rural low-income segment. These are explored in greater depth in paragraphs 200–217, with a consideration of how to overcome them.

Table 7. Main gaps and barriers to insurance coverage in developing countries: consequences and solutions

Objectives, needs	Gaps, barriers	Consequences	Solutions
Insurance against natural disasters and climate change	Risk attitudes, moral hazard	Worsening loss trend, insurers withdraw	Stronger risk prevention regulations
	Large-scale events affecting whole regions, frequent losses	Gaps in availability of insurance coverage	Reinsurance, geographical and hazard diversification, risk pools
	Lack of data on risks and exposure		Better quality and availability of data and projections
	Uncertainty over climate, historical risk data irrelevant for pricing	Unexpected losses, high prices	
	Slow-onset climate change (sea level rise, desertification)	Uninsurable risks	Risk prevention measures, temporal funding such as life and pensions insurance
	Subsidized public insurance, market price controls	Heavy losses for tax payers, private insurance unavailable	Risk-based pricing
	Regulations hinder product innovation	Lack of insurance, slow economic growth	Less rigid government regulations
	Existence of publicly funded disaster relief	Reduced demand for insurance	Public–private partnership to segment market
	Cyclical market	Unstable prices and supply	Multi-year insurance, risk-based pricing
Expanding insurance coverage among the rural poor	Low risk awareness, no familiarity with insurance	Low demand for insurance	Education
	High transaction costs, adverse selection	Increase in cost of premiums	Microinsurance, parametric insurance, bundled products, supportive regulation
	Limited experience in these markets	Gaps in availability of insurance coverage	
	Weak rural financial institutions		Reinforcement of institutional structure

1. Supply-side barriers

Weak rural financial sector

190. Of the major obstacles that prevent the creation of formal financial facilities in developing countries, the primary one is the weakness of the rural financial sector. Much of the rural population has no access to banking or professional financial advice. The banks themselves see the rural sector as problematic, characterized by small accounts and high credit risk. Insurance is a second-phase financial product, and is less easy to distribute because transactions are less frequent than in banking. This

explains the success of microfinance and why microinsurance is being developed – new methods are needed to reach customers.

Unpredictable commercial return

191. The fundamental element of any insurance operation is capital, to ensure that the insurer is able to acquire resources and pay abnormal losses. The capital mainly comes from private investors and the open capital market. These investors expect to receive a return on the investment, in the range of 10–20 per cent. Therefore, insurance companies manage their underwriting so that there is a high probability of an after-tax profit, with a variety of techniques: adequate pricing;[113] substantial deductibles based on the respective exposure; accumulation control;[114] use of reinsurance; attention to loss prevention measures; efficient claims settlement; contractual limit of liability; exclusion of certain risks; and exclusion of areas which are particularly exposed. This can lead to localized or even widespread gaps in the availability of adequate insurance coverage.

Highly skewed risk

192. Natural catastrophes tend to be rare but very large events. Investors prefer a lower volatility to permit steady payments of dividends, and because erratic profits depress the share value. For that reason, reinsurance is heavily used. Because capital reserves are limited, the reinsurer has to levy a significant uncertainty margin to cope with short-term fluctuations in occurrence and severity of catastrophes; this can be a multiple of the long-term risk premium.

193. Alternatives such as equalization reserves[115] are, in principle, equivalent, but may require special accounting and taxation treatment, because the modern accounting practice is to avoid financial transfers between years. Reinsurance supply tends to be erratic, which is a disadvantage for the communities at risk.

Restrictions on the underwriting process

194. A balance is needed between regulatory control of the market (to protect consumers and workers, and promote choice) and flexibility of operating management (to respond to changing circumstances). The insurance industry is susceptible to underwriting cycles arising from uneven loss occurrence or capital market influences, which can distort pricing. Consumers need continuity (insurance policies often end after one year), but investors and underwriters need to be able to respond to changing circumstances.

195. In order to compete, companies need scope for differentiation, for example to underwrite more skilfully, design innovative products or distribute more efficiently. Overly rigid insurance regulations will deter private operators or result in a less favourable solution.

Insufficient data on hazards and exposures

196. Having poor data increases the risk or uncertainty, and means that the private market will be less able, or unable, to bear some of the risk. Geographical, economic and climate data tend to be more readily available for developed countries than for developing countries. In general, accessing and using data requires a fee. A particular issue here is that climate change will create new weather patterns, so historical data on weather events and on losses will be of less relevance in assessing risks and calculating premiums.

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[113] That is, allowing for random annual variance in claims costs as well as the long-run average cost.

[114] That is, ensuring that the pool of risks accepted is as diverse as possible, to mimimize the possibility of a catastrophic loss.

[115] Money is put into and out of an equalization reserve when the actual claims are below or above expected levels, to give a better measure of the long-term performance of a portfolio that is subject to erratic losses.

Risk attitudes and moral hazard: loss prevention

197. If insurers are limited in their ability to introduce appropriate risk-related variations in, for example, deductibles or premium loadings, insurance can lead to a less risk-averse culture. It is therefore vital that public control of the risk management framework (land development, building design, construction standards, etc.) is maintained to avoid such moral hazard. The private sector can be a partner in this: the insurance industry of the United Kingdom actively engages with policymakers on flood defence funding, land zoning and construction standards; in the United States, insurers help to fund the technical training of publicly paid building inspectors; and Australian insurers assisted Fiji in setting standards for cyclone-resistant buildings.[116] A way to promote the wider use of insurance, and so avoid adverse selection, is to make the catastrophe cover compulsory or to bundle it with other services, such as loans or fire insurance.

Limited scale of operation

198. Currently, just 5 per cent of developing country economic losses caused by natural catastrophes are insured (flood, earthquake and agriculture sector risks are often seen as non-insurable). If methods can be found to make these risks insurable, the market potential is large. However, the individual values insured are often small in relation to the insurance transaction cost. In such cases microinsurance could be a more suitable instrument.

199. Private market operators can gain significant economies of administration if they have a parallel operation in the local insurance market that provides other products, such as car insurance, or can derive economies of scale from drawing on their experience in other countries, for example in modelling capability or policy administration systems. Such synergy could be formed with non-disaster weather insurance or market insurance as an add-on with a primary financial product such as a loan, or the sale of an item of equipment.

Limited availability and scale of publicly funded disaster relief

200. Public disaster relief systems (for example emergency subsistence and soft loans) are often set up to cater for victims of natural disasters. This can undermine the viability of a private insurance market.

Non-domestic insurers

201. Restrictions are sometimes placed on the repatriation of dividends, which deters the foreign private market. More fundamentally, there are limitations to the proportion of equity capital that foreign shareholders can hold, which may limit the scale of operations and the speed of growth owing to the small capital base of the domestic partners; there may also be restrictions on access to the global reinsurance market.

2. Demand-side barriers

202. A private market requires customer demand as well as insurer supply. There are various demand-side barriers, some of which the private sector may be able to overcome, while others may need public sector intervention.

Lack of familiarity with insurance

203. Generally, people living in rural areas in developing countries have limited familiarity with how insurance works and it is not easy to provide them with the requisite information; this is a major barrier to market development.

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[116] Dlugolecki et al., 1995.

Perception of risk

204. Often consumers have low risk awareness, particularly regarding low-frequency, high-impact events. The private market can play a useful role in awareness-raising, since it has a profit motive to increase market penetration. Consumers do not usually willingly purchase insurance. This reluctance reduces the market size substantially. Therefore measures which increase the volume, such as compulsory purchase for certain classes of consumer, are generally incentives for the private sector to enter the market.

Price

205. Where the cost of the premium is relatively high, consumers will not insure. The high cost may be a signal from the private market that the risk is very high (unsustainable), or that there is great uncertainty, or that the scale of operations is too small, or that alternative risk management options exist. In general, the population will pay for a product that they believe gives value. The problems with micro health insurance in India are not related to the ability of the poor people to afford the products. Rather, the problem is that the administration system prevents poor people accessing it.[117] Even in the poorest countries of sub-Saharan Africa, people are willing to pay up to 5 per cent of their monthly income for health insurance.[118]

Efficiency

206. The insurance process must be efficient. Recovery must be achieved in acceptable timescales, or consumers will not purchase the product. Here the private operator will seek to attract customers by being more efficient than competitors.

Fairness

207. If consumers believe that others will benefit unduly from the system, or that they are paying more than their 'fair share' to the insurance fund, they will not insure willingly. The private market will seek to segment customers, so eliminating cross-subsidies. However, this may be contrary to public policy in terms of ensuring solidarity.

3. Specific constraints for agricultural insurance

208. With the exception of insurance against hail, most crop insurance involves heavy subsidies to mitigate the expense of the premiums. For example, both the United States and Canada have three forms of subsidy: a direct premium subsidy; a subsidy in the delivery costs; and some form of government sharing for the most catastrophic risk.

209. Global experience with multiple peril crop insurance has been particularly troublesome: the amount paid by the farmer is typically a fraction of the total cost of delivery and underwriting this form of insurance. For example, in the United States, the farmer pays only about 30 per cent of the total cost.[119]

210. Despite a clear need and some strong arguments for the importance of agricultural insurance in economic development, the struggle to find instruments for lower income countries has been long and

[117] Ahuja and Jutting, 2002.
[118] Diaz-Nieto et al., 2006.
[119] USAID, 2006.

arduous.[120] In the 1970s and 1980s, many donors worked to resolve this problem only to abandon the efforts because of the classic problems that plague agricultural insurance: moral hazard; adverse selection; catastrophe risk; and high costs for monitoring, delivery and loss adjustment.

211. Agriculture is a minor sector of the economy in most of the countries that provide subsidized crop insurance. The same is not true in many lower-income countries, so large-scale subsidies are not feasible for them.[121] In many developing countries, rural finance markets are limited and inefficient. The financial service providers perceive the costs of entry and costs of doing business to be high. In addition, default rates in agricultural lending are particularly high owing to the nature of the risks involved in farming.[122]

212. Weather risk is often a correlated risk: many people in an area are affected by a single event. In many cases, the more severe the event, the wider the geographic impact. For example, drought or excess rainfall can create widespread damage across entire regions. Such a widespread, severe weather event would result in excessive loan defaults across the affected area. Restricting the amount of investment in the agriculture sector is one way for a bank or other enterprise to reduce exposure to these risks. Under-investment in the agriculture sector is a rational yet inefficient way to reduce exposure to weather risk. Yet its weakness prevents households from using savings and loans to take more risk such as adopting new technologies and other activities to develop their businesses.[123]

213. Finally, if losses occur frequently, then the rationale for an agricultural insurance system is questionable. Frequent risks require other strategies for mitigation and management. For example, appropriate farming systems and risk-coping strategies must be adopted to fit into a consistently harsh environment such as extremely arid regions.[124]

214. The situation of Africa demonstrates the difficulties. Only five countries provide agricultural insurance. Agricultural insurance schemes are well developed for key commercial crops in Mauritius, South Africa and Zimbabwe, with negligible operations in Ethiopia and Nigeria. A few other countries have entered such markets and withdrawn following bad loss experience.

215. The small size of many private insurers in Africa means they would not have the necessary resources for market development. To provide viable agricultural insurance schemes, a large amount of information on climate patterns, farming systems, credit and inputs, agricultural extension services, loss assessment systems, etc., need to be researched and developed. This would be followed by pilot schemes with extensive education and promotion activties to enable farmers to understand and appreciate the concept and benefits of insurance. The work to be done up to this stage would require an investment of millions of United States dollars. Only then would the insurer be able to produce an appropriate agricultural insurance scheme. Implementating the scheme after completion of all these stages would call for extensive infrastructure throughout the rural farming areas, which would require more resources. For this reason, the initiative for implementation of agricultural insurance schemes can come only from a country's government with the help of external technical assistance.

216. In the 1990s, the African Insurance Organization undertook a detailed study for the introduction of agricultural insurance schemes. However, countries were not prepared to commit to the cost of further research and product development, so the project was abandoned. Other socially desirable insurance schemes for the informal urban sector met the same fate.[125]

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[120] Mapfumo, 2007; Skees and Collier, 2008.
[121] USAID, 2006.
[122] Hess, 2003.
[123] USAID, 2006.
[124] USAID, 2006.
[125] UNCTAD, 2007.

4. Specific constraints in small island States

217. There are several constraints to transferring or sharing risk in small island States. These include the limited size of the risk pool, low capacity due to small population, lack of opportunities for diversification, exposure to more than one severe hazard (sea level rise, flooding and storm, and often earthquake and volcanoes as well) and the lack of availability of financial instruments and services for risk management. Moreover, the relative costs of natural disasters tend to be far higher. For instance, in 2004, Cyclone Heta devastated the tiny island of Niue in the South-West Pacific, leaving the island almost entirely reliant on overseas aid for reconstruction efforts.[126] Natural disasters in countries of the Eastern Caribbean have had a discernible macroeconomic impact,[127] including severe effects on fiscal and external balances, pointing to an important role for precautionary measures.[128]

E. Current insurance options in developing countries

218. Two major innovations have increased the possibility of using insurance as a tool for managing the financial impacts on individuals and small businesses of extreme events. Microfinance institutions and other new organizations have arisen to service the low-income sector (for example the Grameen Bank in Bangladesh), providing credit and additional services such as microinsurance. Very recently, index-based insurance contracts have evolved to provide a simple alternative to traditional loss-based insurance. This section discusses microinsurance, weather index insurance and provides some examples of current practice in developing countries, including African countries.

219. Without insurance, low-income segments face a poverty trap. Smallholders cannot risk investing in fixed capital or concentrating on the most profitable activities and crops, because they cannot leverage the start-up capital and they face systemic risks that could wipe out their livelihoods at any time. Individuals can face destitution if the weather is merely abnormal, let alone extreme. Farmers and communities have a number of coping strategies, both before and after an event occurs.[129] Some of these are efficient (planting drought-resistant variants, conservation tillage, planting in different fields and staggered over time, diversifying income, etc.) and could be continued within an insurance setting, but others are detrimental (distress sales of assets, removal of children from education), and insurance can avoid these.[130]

1. Microinsurance

220. Microinsurance is a method of distributing insurance to reach low-income segments, which has evolved from the practice of microfinance. It is a solution, not for environmental risk, but for social and economic vulnerability. Even in OECD countries, exclusion from financial services is a serious problem; in the United Kingdom, although 80 per cent of households have property insurance, this falls to under 50 per cent for the poorest decile. Table 8 summarizes the key differences between microinsurance and conventional insurance. The microinsurance product range is typically very simple, the sums insured are small, typically around USD 50 to 250, often linked with a microloan, and the distributor is a key player.[131]

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[126] Hamilton, 2004.
[127] Rasmussen 2004.
[128] AR4, Synthesis Report.
[129] Siegel and Alwang, 1999.
[130] Hess et al., 2002.
[131] See <www.microinsurancecompendium.org>.

Table 8. Comparison of microinsurance with conventional insurance

Conventional insurance	Microinsurance
Premium collected in cash or, more commonly, via deductions from a bank account	Premium often collected in cash or associated with another transaction such as a loan repayment or asset purchase Collection modes should respond to the market's irregular cash flows, which may mean frequent premium payments
Sold by licensed intermediaries	Often sold by unlicensed intermediaries
Agents and brokers are responsible for sales and services. Direct sales are also common	Agents manage the entire customer relationship, perhaps including premium collection Often directly sold to groups
Targeted generally at wealthy or middle-class clients	Targeted at low-income clients
Market is largely unfamiliar with insurance in emerging markets. Only corporate customers are familiar with insurance	Market is largely unfamiliar with insurance; large investment in consumer education is therefore required
Screening requirements may include a medical examination	If there are any screening requirements, they are limited to a declaration of good health
Large sums insured	Small sums insured
Priced based on age or the specific risk	Community or group pricing; individual pricing often higher owing to risk level of policyholders and lack of competition on supply side
Limited eligibility, with standard exclusions	Broadly inclusive, with few if any exclusions
Complex policy document	Simple, easy to understand policy document
Claims process may be quite difficult for policyholders	Claims process should be simple while still controlling for fraud

Source: Roth J, McCord M and Liber D. 2007. *The Landscape of Microinsurance in the World's Poorest 100 Countries*. Appleton: Microinsurance Center.

221. About 90 million people globally have microinsurance – mostly health and life.[132] India has had notable success, owing to a 'pro-poor' insurance regulation, whereby insurers have to fulfil a quota of sales in that segment, or the related rural one.[133] Nevertheless, global uptake is still very small in percentage terms. A big difference between microinsurance and microfinance is that in microinsurance the pool of insurance premium is not restricted to one community, but forms part of a larger pool. Thus in principle there can be considerable economies of scale and risk diversification as market penetration rises.

222. The two main types of microinsurance for climatic risks are 'bundled' microinsurance for clients of microfinance institutions, where the insurance is linked to a loan, and 'stand-alone' products targeted specifically at weather risks.[134] The second type may not give any incentive to adapt to climate change because the simple product structure ignores loss prevention,[135] but the bundled product can link risk

[132] Roth et al., 2007.
[133] Roth et al., 2007.
[134] Mechler et al., 2006.
[135] Mechler et al., 2006.

financing to risk reduction, if the purpose of the loan is for adaptation, for example to acquire drought-resistant seed.

223. Initially, schemes are often subsidized, with significant donor support in funding and technical assistance.[136] However, this may change as the benefits of microinsurance become more apparent to stakeholders such as government agencies, NGOs, microfinance institutions and community-based organizations; and premiums are often set on a commercial basis.[137] For the rural poor, a product should remove risks reliably. If this can be guaranteed, even the very poor would pay about one day's wage a month for cover. Nevertheless, most microinsurance programmes for the very poor are publicly supported in a variety of ways.

224. Most poor people are specific about their need for insurance to cover high-frequency risks, many of which are low-impact events, such as common illnesses, crop loss due to pests and drought, and illness of livestock.[138] One step that has yet to occur is the reduction of the interest rate on microloans protected by microinsurance to reflect the lower risk to the lender. Currently, the interest rate contains a significant loading to cover the risk of defaults.

225. Regulators are now turning their attention to the question of how to support microinsurance. Issues such as minimum capital requirements, certification of intermediaries, governance of microinsurers, and product licensing need to balance promoting the sector with protecting consumers. For regulatory adaptations to work, there needs to be a significant investment in capacity-building at many levels. Policymakers and supervisors of the sector have to become familiar with the risks and potential of microinsurance. Donors, international development agencies and other promoters such as insurance associations and international microfinance networks are also still learning and have to be prepared to finance and technically assist the supervisors as well as the microinsurers. Finally, governments, donors and microinsurers have to assume a role in the promotion of insurance awareness and consumer education.[139]

226. Microinsurance for life and health risks is now established on a wide scale (see box 4 for an example). Microinsurance to indemnify losses from abnormal weather conditions is developing: it aims to provide low-income households and businesses with easily accessible and affordable life and health insurance and insurance against loss of small-scale assets, livestock and crops in the event of a flood, drought or other natural disaster. In the pilot stages, the sums insured are relatively small, so a catastrophic loss in a conventional quantum is not possible, but as schemes proliferate, and market penetration rises, microinsurance schemes need to be backed up by formal reinsurance, because natural disaster losses can affect risk pools over a region at the same time.[140]

[136] Mechler et al., 2006.
[137] Roth et al., 2007.
[138] UNDP, 2007.
[139] IAIS, 2007.
[140] Mechler et al., 2006.

Box 4. Microinsurance – a global business

The American International Group views microinsurance (MI) as a worldwide business opportunity, and has a dedicated team developing MI as a main line of business. Global and local partnerships with microfinance institutions (MFIs) are essential to develop appropriate products and then deliver them to clients. The company provides training for these partners on insurance underwriting, distribution and sales. A key issue for MFIs is client education: financial literacy and an understanding of risk management are essential. The first claims payments are always a turning point in demonstrating the value of the product. MFIs themselves need to realize that collecting premiums and paying claims is important.

A project started in Uganda over 10 years ago, in partnership with the Foundation for International Community Assistance, a leading MFI, to offer a low-cost credit life insurance policy coupled with a micro loan. The insurance pays off the outstanding loan if the borrower dies, which mitigates the financial stress on a grieving family, and limits the MFI's risk, thereby allowing more loans to be made. A total of 1.6 million people have life insurance under this scheme, and the product range and coverage has expanded over the years. Similar projects are operating in India and Latin America through banks and self-help groups.[a]

[a] UNEPFI. 2007. *Insuring for sustainability*. Geneva: UNEPFI.

2. Weather index insurance

227. As noted earlier (chapter IV D 3), traditional crop insurance can be too expensive for many developing countries. Since the mid-1990s, work has focused on new approaches that trigger indemnity payments based on the value of an underlying index. Various pilot programmes that use index insurance for agricultural losses are now underway, for example in India, Malawi, Ethiopia, Mongolia and Mexico,[141] and some are being scaled up.

228. The unique characteristic of index insurance is that indemnity payments are triggered by values obtained from an index that serves as a proxy for losses, rather than upon the actual losses of each policyholder. The underlying index is based upon an objective measure, such as rainfall, wind speed or temperature, that exhibits a strong correlation with the variable of interest, for example crop yields or default rates.

229. For cat bonds, the payout is usually all or nothing once the index passes a specified threshold. For the mass market weather derivative product, sold to individuals or small groups, it is usual to have a graduated payout, starting when the index reaches a specified threshold, and rising to a maximum when a specified limit value is reached.

230. Among the many advantages of index insurance are: low moral hazard, since the payout cannot be affected by the policyholder; reduced adverse selection, as the weather data are public; no expensive loss adjustment; less complex data requirements; and simpler contracts. However, index insurance can have a significant limitation – basis risk – when individuals have losses and do not get paid, or, alternatively, they have no loss yet receive payment. For the insurer, such events balance out, but farmers feel they are unfair, which undermines confidence in the system, so basis risk events are to be avoided.

231. Representatives of (re)insurers, donors, development practitioners and climate scientists recently reviewed the status of weather derivative insurance.[142] They agreed that the government's role is crucial. It establishes the regulatory environment for index insurance, and national meteorological services and agriculture extension services provide vital knowledge for insurance design and implementation. There was disagreement about subsidies. However, a wide range of experience suggests that 'smart subsidies'

[141] Skees and Collier, 2008.
[142] Global Humanitarian Roundtable, 2008.

may be useful, that is, ones that aim to kick-start a process. Some considered that subsidies should not be permanently embedded, since they generally lead to poor adaptation and rising costs.

232. The absence of high-quality weather data can impede the development of new schemes;[143] in such cases the probabilities of extremes often have to be estimated through an informed guess as there is insufficient history. A more subtle issue is that historical data have to be re-weighted in the light of climate change trends.

233. The International Research Institute for Climate and Society suggests three objectives or ways that index insurance can contribute to poverty reduction. These have been retitled for clarity, and are shown in table 9, which also describes likely actors and the impacts of index insurance in climatically good years and bad years. The 'crisis safety net' is used to avert humanitarian disaster by protecting very poor people in the face of a severe climate shock. The 'credit safety net' seeks to help populations escape the poverty trap by improving access to credit, increasing land or labour productivity, or enhancing technology adoption or market participation. The 'continuity safety net' is designed to protect the productive assets of those who are not poor, yet are vulnerable, to prevent them from falling into a poverty trap as a result of a climate shock.

Table 9. Weather index safety nets

	Crisis safety net	**Credit safety net**	**Continuity safety net**
Purchased by:	Government, relief agency, non-governmental organization (NGO) or other institution with society-wide responsibilities	Farmer, farmers' association, credit institution, NGO or development organization	Farmer, farmers' association, NGO, government or development organization
Impact of insurance scheme in bad year (when a climate shock occurs)	Payout available when climate shock occurs, allowing a rapid response and minimizing long-term effects	Payout enables creditors to be paid back. Households are protected from the direct impacts and retain more of their assets.	Payout allows for a quick recovery from shock. Productive assets are not compromised, protecting the insured from backward slide into poverty.
Impact of insurance scheme in good year (when no climate shock occurs)	Safety net diminishes uncertainty and enables better decisions by all groups.	Risk distribution allows access to credit and improved livelihood strategies – allowing escape from poverty trap imposed by climate change.	Greater confidence and certainty enable greater investment and economic growth.

234. Experience has shown that contracts will need to adapt each year with changing climate and changing client needs. As knowledge of the weather improves, there are opportunities for increased cost-effectiveness and robustness. This underlines the need for expertise and authority at the local level, with support from the international research community. Intermediaries need to ensure that clients have taken precautions against the possibility of basis risk, and any subsidiary risks that the contract does not address.

3. Examples of household-level index insurance

235. This section presents two cases of weather derivatives in action in Africa, and one in Mongolia. A case study in India is presented in section G below 'Scaling up'.

[143] Skees and Collier, 2008.

Africa (multi-state)

236. In Africa, fear of drought and the farmers' lack of collateral mean that local financial institutions will not provide farmers with credit for inputs like fertilizer and high-yield seeds, because of the high risk of default. Swiss Re launched the Climate Adaptation Development Programme (CADP) in 2007 to address this problem, as its commitment to the Clinton Global Initiative on sustainability.[144]

237. In the initial phase of the CADP, Swiss Re entered into a partnership with the Millennium Promise Alliance and the Earth Institute at Columbia University, and developed weather derivative contracts for three village clusters in Kenya, Mali and Ethiopia against severe drought. Payout of the products is based on a climate index developed by the Earth Institute that uses a combination of satellite and weather data as an objective measure of crop production. Donor funding is a decisive element in early product design as local financial markets lack the capacity to carry out their own analyses and/or cannot afford the opportunity costs.

238. Major challenges include: education (e.g. promoting the importance of purchasing ex ante risk-transfer solutions even though immediate payoffs may not occur); coordination of stakeholders such as farmers, banks, insurance companies and the regulator; product distribution; administration of cash flows; and documentation.

239. On the retail and smaller-sized corporate level, insurance should aim to be self-financing. However, there are considerable start-up costs, and the initial design may need to be refined over several seasons. Here, donors and governments can play a vital role in utilizing their networks for product distribution and subsidizing the cost of risk transfer during the start-up phase.

240. The first drought risk index was created in 2007 in Kenya, using 25 years of data to develop a weather index with a high correlation to maize production. On this basis a weather derivative contract was tailored to the needs of the Millennium Village in Sauri. During 2007, indices were developed for Koraro (Ethiopia) and Tiby (Mali) to provide a total of 150,000 farmers with cover.

241. The derivatives have two triggers: a drought with an expected frequency of once in 8 years, and a more severe one of once in 20 years. Payouts will be used for direct delivery of local goods and services to secure the livelihood of the local community, including emergency food aid, support for the school feeding and nutritional supplementation programmes and support for the local clinic. The three village clusters covered in 2007 received a total protection of about USD 2 million. Originally the cover sought had been higher, but it had to be scaled down because of lack of funding. In 2008, the scheme will extend to six village clusters with a total sum insured of USD 4 million, and it will increase to the full number of twelve village clusters in 2009, located in Ghana, Malawi, Nigeria, Rwanda, Senegal, Uganda and the United Republic of Tanzania.

Malawi

242. Rainfall deficits are a dominant risk faced by farmers in Malawi. Index insurance has been used as a means of removing the risk of rainfall deficits, giving microfinance institutions the confidence to provide farmers with loans to purchase higher-quality inputs, and in turn increase productivity and income. Farmers have stated that their primary strategy for adaptation to climate change is enrolment in the index insurance programme, which is unsubsidized.[145]

243. In 2005 a packaged loan and index-based microinsurance product was offered by the Opportunity International Bank of Malawi (OIBM) and the Malawi Rural Finance Corporation to

[144] Information available from <http://commitments.clintonglobalinitiative.org/projects.htm?mode=view&rid=209677>.
[145] Osgood et al., 2007.

groups of groundnut farmers organized by the National Smallholder Farmers' Association of Malawi. A total of 892 small farmers entered into loan agreements with a higher interest rate that included a weather insurance premium, which the bank paid to the insurer, the Insurance Association of Malawi. In the event of a severe drought (as measured by the rainfall index), the borrower paid a fraction of the loan due and the insurer paid the rest to the bank. Without this assurance, banks rarely loan to high-risk, low-income farmers. The advantage for farmers is that they obtain the credit they need for investing in seeds and other inputs necessary for higher-yield crops. The World Bank together with OIBM was the catalyst, with Malawi Meteorological Services providing invaluable assistance.

244. The insurance premiums were substantial, 6 to 10 per cent of the insured values, depending on the location, with no subsidy. A key component of the implementation was to hold training sessions for the field, insurance and operations staff of the institutions involved. Without this, the insurance, banks and small-farmer associations would probably not have participated in the scheme. The first season was problematic because the groundnuts were a new crop and the seed supplies were of poor quality.[146]

245. In 2006 the pilot expanded to 1,800 farmers with more weather data, but focusing on high-yield maize where suppliers were reliable. Without loans, farmers had been unable to buy this maize, which more than doubles farm output. The 2007 season saw further expansion. Five banks promised to unlock more than USD 10 million of credit for agricultural loans if the weather risk was insured. The organizers used the increased size to give economies of scale and critical diversification for insurers, which in turn reduced average premiums, and made the scheme more attractive to reinsurers, and less risky for local insurers. In 2008, Swiss Re announced that it would provide USD 5 million weather-index reinsurance for the maize crop.

246. Weather data are a barrier to further growth. Malawi Meteorological Services estimates that the current facilities can service 100,000 tobacco farmers, and an upgrade of 50 stations could capture 300,000 farmers, at a cost of USD 1.2 million. Remote observation may be able to supplement this.

247. There is also an extensive training and capacity-building programme to develop local expertise on product design and generate confidence in banks, insurers, business associations and policymakers for 'copycat' products in other agricultural and economic sectors. Potentially, the project could have a significant effect on Malawi's climate change resilience and economic development.[147]

Mongolia

248. The Mongolian Index-based Livestock Insurance Pilot, supported by the World Bank, offers insurance to herders to protect against high livestock losses resulting from a severe winter. Private insurance companies sold index insurance for livestock to 2,400 herders in 2006, the first pilot year. This exceeded expectations – nearly 10 per cent of the herders who were eligible purchased the insurance in the first year. The index is based upon county-level livestock mortality rates that are collected by the national statistics office. Although the index is based on livestock mortality and not on a specific weather event, the major underlying cause of large livestock losses is severe winter weather. Importantly, the Mongolia project explicitly separates the commercial and the social side of the insurance. Commercial insurers sell the base insurance product (BIP), which indemnifies for losses when livestock mortality for the county is between 7 and 30 per cent. When losses exceed 30 per cent mortality, the government pays for them with a disaster response product (DRP). Herders who do not purchase the BIP can pay a small fee to register for the DRP. Two of the primary rural lenders that are making microloans to herders have already discounted interest rates for herders purchasing the BIP.[148]

[146] Mechler et al., 2006.
[147] Bryla et al., 2007.
[148] USAID, 2006.

249. The Government of Mongolia is doubly exposed to livestock risk under the scheme. First, it covers excessive losses through the DRP. Second, it acts as a reinsurer of last resort for the insurance companies selling the BIP. If the aggregate losses through the BIP exceed a specified amount, the additional losses pass to the Government under an unlimited stop loss reinsurance treaty. This double exposure needs to be adequately financed to avoid an increase in the fiscal burden of the Government of Mongolia. The financing of the Government's potential losses during the pilot phase relies on a combination of reserves and a USD 5 million contingent credit provided by the World Bank.[149]

250. As at October 2008, progress towards meeting the project's development objective has been good. The first full cycle of the insurance pilot was concluded in August 2007, and although claims on the policies were small, these were successfully distributed. The third selling season was open from April to July 2008, and preliminary figures indicate that sales were again high, exceeding the original targets. The 2007/2008 winter in Mongolia was severe, triggering significant payouts of the insurance and requiring the Government to draw down on the contingent debt facility. Indemnity payments are being distributed. During this pilot phase, the mechanisms and institutional capacity for operating the index-based approach were well tested. The indications are that the approach is viable in Mongolia and that a phased scale-up should be considered.[150]

4. Examples of meso-level (intermediate) index insurance

251. From the point of view of administration, it is much easier to insure the intermediaries who provide goods and service to the mass rural markets, since they are generally smaller in number but much larger individually in terms of assets. They are more accessible, and familiar with financial products. If they can be cushioned against the effects of extreme weather, they may be more willing to accept a degree of weather risk default through their clients. In that way there would be an indirect benefit to the low-income segment, although they might still be exposed to the weather risks themselves. This strategy is recommended by some, but it seems to leave the rural farming and informal urban segments with an unresolved exposure to weather risk. This section presents two short cases, one in Peru, one in Mexico.

Peru

252. Due to the El Niño Southern Oscillation (ENSO) in the Pacific, there are periodic spells of extreme rainfall in the northern regions of Peru. These conditions result in a large increase in the number of loan defaults to microfinance institutions (e.g. from around 8 per cent to about 18 per cent in 1998), at the same time that depositors need to withdraw cash for immediate use. The United States Agency for International Development (USAID) proposed a simple insurance contract that would pay when the sea surface temperatures off the coast of Peru are roughly 2 °C above normal. This ENSO insurance would protect the portfolio risk of the intermediaries, the microfinance institutions and other rural lenders.[151]

253. The insurance regulator of Peru approved this novel ENSO insurance product. At this point, an insurance company in Peru and a global reinsurer are pursuing the market and several lenders have expressed an interest in purchasing the contract.[152]

Mexico

254. Small cattle ranchers rely mainly on natural pastureland to feed their animals. Climatic events such as droughts reduce the available biomass (plant material). The weather insurance scheme is innovative and provides funds to purchase additional feed to maintain the herds. The available biomass

[149] Mahul and Skees, 2006.
[150] World Bank, 2008.
[151] USAID, 2006.
[152] Skees and Collier, 2008.

is measured by a vegetation index, calculated by infrared and red spectral measurements from daily satellite images.

255. The index was devised by Agroasemex, a Mexican state-owned reinsurance company. The scheme is open exclusively to federal and/or state Governments in Mexico, who in turn reinsure the *Fondos*, mutual insurance pools formed by local farmers. Agroasemex finally reinsure some of the risk to the international reinsurers Swiss Re.

256. The sum insured is fixed at approximately USD 38 per animal. The scheme has grown from a total sum insured of USD 22.4 million in 2005 to 90 million in 2007. Further expansion has been hindered by lack of meteorological data; however, Agroasemex is working on techniques for utilizing shorter time series of data.[153]

5. Discontinued programmes

257. There are many reasons why some index insurance schemes fail. It is important to use these as learning experiences, so that false starts are avoided in future, and new schemes are as efficient as possible. The following two cases illustrate some of the practical difficulties that arise.

Ethiopia

258. A pilot weather index programme was launched for maize farmers in southern Ethiopia. Only 30 of the drought policies were sold during 2006 and the project closed after the pilot. The pilot failed to identify any organizations that could be used to reach clients effectively and provide capacity-building and product education to farmer clients. Commonly, banks act as a distribution agent, but in this case no banks were willing to get involved since their fertilizer loans (to farmers) were already guaranteed by the Government. As the insurance company had no existing network in the region, it was unable to inspire trust among sceptical farmers.

Morocco

259. In 1995 the Government of Morocco introduced a state-sponsored yield insurance scheme against drought. The programme was very popular (in 2002 penetration reached 80 per cent of the 300,000 authorized hectares), but was affected by high costs associated with fraud, monitoring for moral hazard and adverse selection, and loss adjustment. In 2001 the World Bank suggested a project to evaluate the possibility of introducing weather index insurance.

260. The proposed insurance was sophisticated, with multiple triggers to reduce basis risk. Farmer test groups had difficulty in estimating the value of the product. The drought insurance was to be sold through branches of the agricultural mutual insurance company, but implementation did not take place. The rainfall precipitation data in the selected pilot areas showed a downward trend. Based on this information the reinsurance company that was prepared to accept the risk proposed a premium that was too high to be passed on to policyholders.[154] Effectively, this signalled that the activity was uninsurable, and therefore unsustainable.

F. Public–private partnership

261. This section outlines the case for public–private partnership (PPP), discusses the way that PPP could operate in weather insurance schemes, and reviews the case for subsidies.

[153] Skees et al., 2007.
[154] Skees et al., 2007.

1. The case for public–private partnership

262. Public-sector resources are needed for many different purposes, so it is appropriate to consider how the private sector can contribute to managing the risks of climate change. The private sector can participate in large-scale adaptation initiatives only on a commercial basis. Image and corporate responsibility are not sufficient. In partnership with the public sector, mixed solutions can often be discovered, and the public sector and those at risk can benefit from the private sector's inherent need to innovate and be efficient so that it generate returns for investors.

263. Key areas for public finance are: start-up finance to overcome the inertia of the status quo, public goods such as data and climate-proofed infrastructure, and finance for the most severe risks or most risks that cannot typically be covered by commercial insurance. Subsidies to users or providers of a weather insurance scheme should be used sparingly, taking into consideration that this should not lead to the diversion of scarce funds from more effective programmes, and that maladaptation should not be encouraged (through moral hazard).

264. Using the private sector may have advantages apart from freeing up public resources. For those risks that it finances, the use of risk-related pricing is an efficient risk shadowing device. The presence of international (re)insurers spreads risks globally and facilitates the fast communication of lessons. At the same time, the availability of specialists for different functions allows a variety of approaches to be used in different countries. Through consultancy, the private sector can support the functions that the public sector performs. In addition, it can provide lower-risk insurance through competitive products, market and distribute public- and private-sector insurance products and undertake loss-handling procedures. Finally, with its emphasis on profit, the private sector is, in general, innovative, while it provides a tight administrative system to control fraud and can use overflow capacity from other operations and even other territories in time of emergency.

2. The possible roles of the private and public sectors

265. Table 10 tentatively outlines various issues related to designing and operating a weather insurance scheme with regard to the possible roles of the public and private sectors. These possible roles may change in accordance to the different national circumstances.

Hazard knowledge

266. Governments in developing countries should view the timely availability of high-quality weather data as an important public good that would greatly enhance the transfer of weather risks through both public and private means. This should be complemented by data on the assets at risk. Governments can also invest in public awareness campaigns that will reduce human and material losses, and foster the growth of insurance markets. The private sector has the international capacity to model hazards, if the data are available.

Loss prevention

267. Loss prevention is a critical function. Those at risk, from individuals through communities up to nations, should be assessed strategically for their potential maximum loss (PML) when planning adaptation measures, and in detail when constructing a risk-transfer system. Without strong public regulation on land use and building design, the natural tendency is for PMLs to rise rapidly, making adaptation more difficult and risks uninsurable. Insurers could be more active in framing their insurance contracts so that weather-resilient assets are favourably rated.

Table 10. Possible roles of the public and private sectors in a weather insurance system

Area	Public sector	Private sector
Hazard knowledge	Basic data and research, awareness-raising	Risk modelling
Loss prevention	Regulation and enforcement, physical infrastructure	Incentives in product design
Vulnerable segments	Regulation, awareness-raising	Provision of microinsurance backed by reinsurance
Risk transfer	Addressing high-risk or inaccessible sectors, guarantee fund/volatility smoothing	Provision of insurance where insurability exists Services for public schemes
Loss compensation	Basic disaster aid	Claims payouts under insurance contracts, services for public schemes
Capacity-building	Funding	Technical assistance
Economic stability	Security, sound financial policy	Enhancing availability and accessibility
Financial markets	Policy and governance, provision of access to foreign capital	Product design, distribution and marketing, administration

Source: Based on United Nations Environment Programme Finance Initiative, Climate Change Working Group. 2006. *Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector*. Available at: <http://www.unepfi.org/fileadmin/documents/CEO_briefing_adaptation_vulnerability_2006.pdf>.

Vulnerable segments

268. In many countries it may be possible to build a safe haven even from sea level rise and water scarcity. Given the limited resources, this could be more difficult in developing countries. The experience of India in promoting the rural insurance sector is instructive. This was done by a pro-poor regulatory requirement for formal insurers to take on an increasing quota of low-income clients.[155] Furthermore, there is a provision that regulated insurers must increase their shares of low-income clients serviced over time.[156] This could potentially imply that insurers wishing to operate in India may operate their rural business with cross subsidies from their other lines of business and wealthier clients. However, innovation in distribution and product design has led some insurers to regard the low-income market as a (potentially) profitable market.[157]

269. There may be sectors of the very poor who cannot afford to pay premiums, and are inaccessible to the financial sector. In these cases a public, post hoc system may be the solution. These loss risks are socialized across all taxpayers.

270. For poorer countries, national-level catastrophe insurance may also receive donor support in the form of free risk capital or subsidized insurance premiums, for example. Such support is essential for the most vulnerable countries, as it enhances adaptive capacity and also helps avoid potential cross-border implications such as conflict and migration.

[155] Mechler et al., 2006.
[156] ADA, 2004.
[157] Krishna, 2005.

Risk transfer

271. If risks are insurable, adopting a private market system is the usual course of action, with appropriate safeguards for consumer protection. The private sector may be able to act as underwriting agent for the public sector, even if it does not finance the risks itself.

272. A possible role for government, donors or other sources of financing is to provide resources for addressing low-probability, high-consequence events. Evidence suggests that those at risk tend to ignore the probability of the most extreme and infrequent loss events, but insurers need to load their premiums considerably to allow for them happening. This creates a gap between what buyers are willing to pay and what sellers are willing to accept for protection against very infrequent but catastrophic losses. Governments can provide the financing in a number of ways that still provide incentives to domestic insurers to operate in a proper fashion.[158]

273. Very extreme events may exceed the funds available, particularly in the early years when a surplus has not accumulated or a sufficient volume of business been established. The excess amount may need to be guaranteed, perhaps through contingent loans from government and/or donors. The Mongolian Index-based Livestock Insurance Pilot described earlier has such an arrangement with the World Bank (see para. 248).

274. The government may assume weather risks for its own account, and cede at least a part of their catastrophe risk peak accumulations outside the country to the global reinsurance or capital markets. For example, the Government of Turkey assumes some of the risk of earthquakes destroying homes. The Government of the United States, through the National Flood Insurance Programme, assumes some of the risk of flood damage to homes. In both cases, the Governments clearly limit the amount of loss they are willing to assume for each home.

Capacity-building

275. This can take the form of technical assistance such as feasibility studies, providing insurance expertise, access to data, carrying out risk assessments, designing products and facilitating public–private partnerships, as well as financial support to cover administrative expenses, research and investment. Under the Convention, the Global Environment Facility already funds programmes of this nature. Other sponsoring institutions include the World Bank, the ProVention Consortium and Oxfam.

Economic stability

276. The financial sector needs government to provide good levels of public security and social order. This will stimulate effective demand for credit and insurance, and incentives to save or invest. For its part, the financial sector should support public-sector policies for sustainable development by seeking to ensure that they are framed in economically viable terms.

Financial markets

277. The government may consider removing regulatory and structural barriers that limit the operations of private risk-sharing markets. This may include introducing restrictions on foreign-owned businesses. In fact, managing climatic risks will imply rapid growth in the insurance sector, with heavy investment for the initial years and little dividend for shareholders. In many cases the domestic financial sector may not be attracted by these prospects, but foreign insurers may be willing to fill the gap.

278. Another example is that insurance regulations in many countries do not envisage the use of weather derivatives as insurance or reinsurance instruments. This is particularly true in developing

[158] USAID, 2006.

countries. For example, a local insurance company may wish to use weather derivatives to hedge its portfolio of weather-related insurance policies. If insurance regulators do not recognize weather derivatives as an effective mechanism for transferring risks, they may require the company to keep in reserves the full notional amount of outstanding insured risks.

G. Scaling up and replicating pilot insurance programmes

279. The fragmentary nature of the mass market in developing countries makes it difficult to replicate a local success; languages and customs may differ, communications are often poor, co-ordination between agencies may be inadequate. Valuable lessons can be learned from the experiences of the pioneers, in particular in India (see box 6) and Malawi (see paras 242–247). In the case of weather derivatives in India, piloted by the NGO BASIX, sales of weather index insurance rose from just 1,500 policies in 2003 to 675,000 policies in 2008 in one state, Rajasthan, alone.[159]

280. As box 5 shows, the scale-up is part of a lengthy process that begins with identifying a significant weather problem, and a constituency that requires a crisis, credit or continuity safety net to meet it. Finding partners is crucial. These should be capable of supporting a wider project, have good relations with the potential clients and have a stake in solving the problem.[160] It will then be easier in future to scale up with known partners than to scale across with new partners in fresh territories. Partners with a wider geographical scope will also see the possibilities of economies of scale and market recognition for themselves as the scale-up proceeds. Reinsurers may benefit from negative correlations for pooling risk. For example, an ENSO status that is associated with higher probabilities of drought in Southern Africa is correlated with ample rainfall in the Greater Horn of Africa.[161]

281. For simplicity, an indexed insurance product is recommended for scaling up, which requires careful design to avoid basis risk but retain simplicity. Another consideration at that stage is affordability. It would be false to experiment with a product that is not priced to the risk, but it does seem fair to exclude the development costs, and also to assume economies of scale and the benefits of reinsurance that will apply to a fully scaled-up scheme.

282. Issues such as timing of the sales campaign in relation to the growing or breeding season, and the availability of seasonal forecasts are important. The insurance should provide payouts of a size and frequency that clients need. Ideally, it should convey adaptation or resilience benefits, such as being linked to credit for improved agricultural inputs or building materials.

283. The pilot exercise is a crucial element on the road to scaling up. It provides the opportunity to refine the product over a number of seasons, and to develop a communication strategy for clients. The demonstration effect of the pilot is a very powerful tool when reaching out to an inexperienced audience. Preliminary work should start on the scale-up while the pilot is running. Weather data will be fundamental – this could be very expensive to develop and therefore may need sponsors or public funding, and must be tamper-proof. A flexible reinsurer will be required to absorb the catastrophe risk, and regulators need to ensure that there are no obstacles to the envisaged microinsurance.

[159] Barrett et al., 2007.
[160] CGAP, 2008.
[161] Osgood et al., 2007.

Box 5. Key steps in scaling up mass insurance

1. Identify a key weather risk that requires a crisis, credit or continuity safety net;

2. Recruit partners

- motivated and capable
- representatives of local government agencies/ distributors/ at-risk segment
- international donor/(re)insurer/non-governmental organization

3. Model the disruptive weather

4. Create an indexed insurance product

- linked to banking or value chain activity
- for micro-level insurance
- priced at scaled-up cost structure

5. Conduct a meaningful pilot insurance exercise

- possibly over two to three years

6. Refine the product during the pilot

7. Plan the scale-up during the pilot

- multi-agency project team
- reinsurance/ weather data/ regulations
- revised product
- well-briefed 'champions'
- detailed roll-out plan

8. Roll-out in phases, with continual two-way information flow on progress

9. Encourage other microinsurance products

- subsidiary activities
- asset insurance

Source: Based on Skees J, Murphy A, Collier B, McCord M and Roth J. 2007. *Scaling Up Index Insurance – What is needed for the next big step forward?* Available at: <http://www.microinsurancecentre.org/UI/..%5CUploadDocuments%5C080911a%20Scaling%20Up%20Index%20Insurance%20Final.pdf>.

284. Some experts have recommended an indirect three-stage strategy for insurance market development. The first stage would involve applying weather insurance to meso-organizations, such as banks or agricultural suppliers, that serve the mass market, in order to make that segment of business less risky for them. In the second stage, new weather products would still be sold to the meso-organization, but they would be designed to offset debtor defaults. Finally, the third stage of development would provide weather insurance directly to the mass market.[162] This stategy seems far too laborious; it would take perhaps 10 years to reach stage 3. During that period, people in the lower-income segment would continue to face losses, and would be denied the opportunity to become familiar with insurance. Income differentials would widen, and there would be resistance to the third stage development from those who had benefited in the first two stages. Moreover, there is ample evidence now that the low-income

[162] Skees et al., 2007.

segment can use microinsurance and weather derivatives when they are introduced properly. There is every prospect that they will become increasingly sophisticated in their financial risk management.[163]

Box 6. Scaling up in India

The first micro-level rainfall insurance in the world was launched in India in 2003, through close collaboration between BASIX (an Indian microfinance institution (MFI)), the World Bank and private insurers and reinsurers. Planning started in 2000. The pilot scheme was tiny and the products and systems rather simple. A major expansion took place in 2005 with a simplified product and streamlined administration. Over 7,000 policies were sold, and other insurers followed suit. This initiative has succeeded owing to strong collaboration between all the partners, with doorstep delivery, quick claim settlements and strong communication (see figure below). As much as 90 per cent of new customers come from 'word of mouth'.

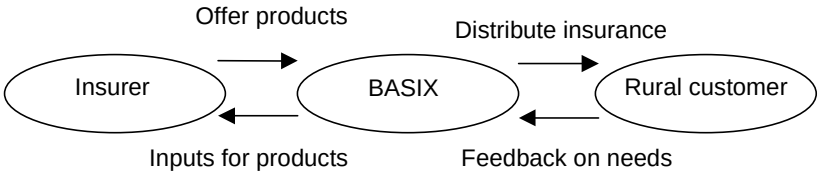
The premium rates are not low, at between 5 and 12 per cent of sum insured, but insurers will not participate unless the scheme is viable, and clients are willing to pay if the claim settlement process is fast and fair. The initial underwriter, ICICI Lombard, now sells weather insurance for crops and salt and brick manufacture via BASIX, other intermediaries and retail (direct).

All the stakeholders gain: government by reduced relief payments and social problems, and easier budgeting; the insurer by fulfilling his social insurance quota; the MFI complements its client services and reduces the default rate on its loans; the poor farmers receive reliable protection for their income and assets; and overseas development agencies avoid disruption from emergency relief calls, and can claim speedier assistance for clients. Wider schemes would benefit intermediaries, by generating more revenue; and banks by protecting their credit risk.

The agents are enthusiastic about expanding further. It will help to absorb the development and overhead costs, make better use of staff time with a wider product range and underpin rural economic development. For BASIX, the opportunity to partner with multiple insurance companies can overcome the underwriting limitations incurred by reliance on one company.

From the insurer's viewpoint, the product was not profitable initially, but that was felt to be because the policies were being too narrowly concentrated geographically – a wider area would reduce the expected risk. Competition was less pronounced than for products like Motor insurance, and the rainfall product helped to fulfill official social targets.

BASIX insurance business model



H. Examples of national-level and international-level index insurance

285. Catastrophe insurance can offer great benefits to developing country governments, since natural disasters can jeopardize their entire economic development. Progress has been slow because of the difficulties of estimating loss potentials and verifying losses. In addition, many countries may not be able to afford the premium, or they do not wish to commit to the certain expense of an insurance premium when the payout is unsure and may be difficult to obtain. The use of index insurance seems to have broken the logjam, using the format of cat bonds. Finally, the possibility that forests might be monetized raises the possibility of using insurance to safeguard that capital (box 7). Significant new regulations would be required to initiate such a programme.

[163] Osgood et al., 2007.

Mexico

286. The Government of Mexico is using index insurance to reinsure two disaster relief funds: FONDEN and FAPACC. FONDEN – the Mexican national fund for natural disasters – was created in 1995 to provide disaster relief funds for the repair of uninsured infrastructure and relief for low-income victims of disasters. FAPACC is a specialized natural disaster fund established to provide immediate assistance to restore the productivity of subsistence farmers by protecting the productive assets of vulnerable populations without access to formal insurance markets. The programme offers contingent payments for damage to productive assets caused by drought, frost, hail, excess rainfall and flood, and windstorm. By using index insurance to reinsure the government emergency response, the Government is able to maintain the sustainability and solvency of the disaster relief programmes.[164]

Ethiopia

287. The World Bank and the World Food Programme (WFP) developed a rainfall index contract to pre-finance some WFP emergency operations in Ethiopia. The index insurance, purchased through a global reinsurer, AXA Re, provided WFP with rapid and predictable funding, and was expected to improve the timing of its response to a drought crisis by four months. The amount of the protection purchased was a fraction of the total needs, since often a quick response can greatly reduce the overall costs by allowing victims to start the recovery process earlier.[165]

288. Paradoxically, the contract was not renewed after 2006. The rationale was that WFP is supported by higher income countries, and that insurance was an unnecessary expenditure. This ignored the timing benefit for aid recipients. The ex ante funding for disaster relief remains a promising outlet for index insurance, particularly for entities that have relatively limited access to capital for emergencies, such as NGOs and governments of lower-income countries.[166]

Caribbean

289. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) resulted from a Caribbean Community (CARICOM) initiative following major hurricanes in 2004, and therefore has local government backing. It received seed funding from donors for the development stage and to finance a substantial proportion of the premiums. Professional risk-modelling techniques were used to develop country risk profiles and to design and price parametric insurance products for each country based on the individual country risk profile, thus addressing concerns of participating countries about potential cross-subsidization.[167] The cost of reinsurance is affected by the sophistication of risk modelling employed, and therefore this use of professional risk modellers will have a positive impact on the cost of re-insurance.[168]

290. The CCRIF provides funds purely for emergencies, and not for reconstruction, private property or business interruption. The reliance on parametric payouts crucially means that payouts should be speedy. The CCRIF currently has no linkage to the local finance sectors because it has very limited objectives. The payout goes directly to governments, with no strings attached. According to the World Bank, this is acceptable for the limited amounts that will be available. There is also no mechanism to deal with early exhaustion of the fund.

291. Experience shows that governments have often lost interest in insurance after a few years without disasters. However, the use of cat bonds at least injects a 3–5 year commitment, rather than the annual reinsurance cycle or annual government budgets. One weakness is the lack of risk reduction

[164] USAID, 2006.
[165] USAID, 2006.
[166] USAID (2006)
[167] World Bank, 2006.
[168] N Silver and A Dlugolecki, personal communication.

features. A possible extension of the CCRIF into insurance, for example for large infrastructure, would require significantly more attention to risk analysis and reduction, where insurance industry expertise could be invaluable. There are some concerns that the instrument is too tightly defined, since some participant countries suffered significant losses in 2007 and 2008 because of intense rainfall, but received no payout because the trigger conditions did not apply.

Box 7. Forests and insurance

Forests are a central aspect of climate change policy. Around 20 per cent of emissions are derived from deforestation.[a] Forests are also vulnerable to climate change, from changes in weather conditions, fires, and pests and diseases. Preserving forests against these threats is crucial, because of the ecoservices they provide, from storing billions of tonnes of carbon, the release of which could accelerate climate change, to purifying water and providing natural flood controls, to providing a home for rare species of flora and fauna.

Discussions under the designation of REDD (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries), and more generally under the United Nations Forum on Forests aim to create frameworks which would assign value to these services, and encourage developing countries to preserve them as carbon sinks.

Direct private investment in the global forestry sector has been estimated at USD 23 billion in 2005, accounting for 90 per cent of total forest finance.[b] However, private capital is unlikely to increase quickly due to concerns over political risks and loss control 'on the ground'.[c] Many commercial forest owners do not purchase insurance, but rely upon geographical diversification and physical risk management such as removal of underbrush. However, insurance will be needed for unmanaged forests, and to safeguard large-scale investment and small communities.

Underwriters have been reluctant to cover elemental risks to forests because of the difficulties of loss control in remote forests.[d] Moral hazard is also a problem as it is with agricultural risks, not to mention catastrophic events such as hurricanes or fire. This situation could soon change, owing to a combination of positive developments.[e] Remote monitoring can identify problems quickly, and modern communications enable information-sharing with any location. Advances in science have produced more sophisticated meteorological and biosystem models to explore potential risks. These are complemented by geographical information systems and probabilistic risk modelling. The final element is the growth of financial weather risk markets. These provide more capacity and offer longer tenor of protection than annual policies, which is important for direct investors in forestry.[f] At the same time they could offer investors an uncorrelated class of assets, and an alternative way to participate in sustainable forestry. One estimate of the potential carbon markets in forests is USD 90 billion by 2020.[g]

[a] Stern, N. 2008. *Key Elements of a Global Deal on Climate Change*. Available at: <http://www.lse.ac.uk/collections/granthamInstitute/publications/KeyElementsOfAGlobalDeal_30Apr08.pdf>.
[b] Stern, N. 2008. *Key Elements of a Global Deal on Climate Change*. Available at: <http://www.lse.ac.uk/collections/granthamInstitute/publications/KeyElementsOfAGlobalDeal_30Apr08.pdf>.
[c] International Institute for Sustainable Development (IISD). 2008. *Paramaribo Dialogue Bulletin: A Summary Report of the Country-Led Initiative on Financing for Sustainable Forest Management in support of the UN Forum on Forests (UNFF)*. Earth Negotiations Bulletin 152 (4) 15 September 2008. pp.9.
[d] Cottle, P. 2007. Insuring Southeast Asian commercial forests: Fire risk analysis and the potential for use of data in risk pricing and reduction of forest fire risk. *Mitigation and Adaptation Strategies for Global Change*. 12(1): pp.181-201.
[e] Cottle, P. personal communication.
[f] First Forest. 2008. *Forestry for Climate Change Mitigation: Opportunities and challenges for an increase in acquiring capital – a contribution towards a framework for risk management and risk products*. Discussion Paper. Munich: First Forest.
[g] Caisse des Dépôts. 2008. *Climate Report No 14 – Reducing Emissions from Deforestation and Degradation: What Contribution from Carbon Markets?* Paris: Caisse des Dépôts.

I. Conclusions

292. In developing countries there are significant barriers to the use of insurance. Financial systems are generally weak, public awareness of financial risk management is low, and conventional insurance products are too expensive. This is compounded by the fact that climatic risks are often more severe, and so more problematic to insure, particularly in SIDS.

293. National adaptation plans could provide the basis for public–private partnerships to manage the economic costs of climatic impacts through insurance. Barriers to private insurance could be reduced by a mix of regulation and publicly funded actions. Prospective regulations on real estate development, construction standards, and retrofitting in hazard zones could maintain insurability. Flexible regulations would promote innovation through indexed insurance and micro-institutions. Non-domestic insurers could be attracted by removing trade barriers, minimal interference with actuarial premiums, and access to international reinsurance markets.

294. Key areas for public finance include funding for public goods risk-relevant data such as weather maps, and major hazard reduction projects such as flood control. Feasibility studies including demonstration or pilot insurance schemes could also be funded.

295. Recently, major advances have been made in developing weather index insurance products that could help developing countries to cope with the impact of extreme events, particularly for their rural communities. In particular, weather derivative products for the mass market are simple and payouts are rapid and transparent. There are major practical hurdles to overcome, such as distribution in rural areas, public unfamiliarity with insurance, and lack of consumer awareness of weather data, but the technical issues have been resolved. However, the capacity to introduce such systems is lacking in the LDCs, SIDS and many countries in Africa, in part because they require a sophisticated level of technical and financial expertise.

296. The development of microfinance, and now the innovation of microinsurance, for low-income segments offers great promise in tackling economic risks related to the climate. Initial experience indicates that products can be viable without subsidies once the initial costly research and development has been accomplished. Furthermore, it is possible to link microinsurance to the financing of adaptive measures such as agricultural improvements, so that resilience is enhanced. A useful classification is to define the aim of a microinsurance scheme as a crisis, credit or continuity safety net, depending on the level of income of the target group.

297. An effective way to achieve weather insurance programmes nationally is to carry out a local pilot scheme with partners that will be capable of carrying out the wider implementation. The pilot allows the product to be refined so it truly meets needs, and it is a powerful tool in communicating the concept during later stages. The pilot phase may take up to three years, but that time is necessary to build trust among partners, and prepare the infrastructure for national roll-out, including developing weather data, modifying insurance sector regulations, negotiating reinsurance and training local facilitators.[169]

V. Potential financial solutions for developing countries

A. Introduction

298. This chapter discusses potential financial solutions designed to manage the financial risks from the direct impacts of climate change, in order to mitigate the consequences for the public and private sectors. The financial options presented in this chapter focus on innovative insurance tools for public–private partnerships, with an emphasis on support for SIDS, LDCs and countries in Africa.

[169] CGAP, 2008.

299. This chapter covers risk management and financial risk structuring as follows:

(a) Sections B, C and D provide the conceptual basis of financial risk structuring for climate change risk management;

(b) Section E applies the concepts developed in B, C and D to develop a hierarchy of risk-transfer schemes for SIDS, LDCs and countries in Africa;

(c) Section F discusses the roles of the main stakeholders in the proposed solutions;

(d) Section G highlights potential challenges in implementation, and proposes a further novel insurance instrument. This latter instrument is an all-risks parametric insurance, which may be able to deal with slow-onset hazards and minimize basis risk.

B. Managing risk

300. There are three strategies for risk management: risk reduction, risk retention and risk transfer. Typically, an efficient solution requires a combination of all three. Each has its costs and benefits, and based on cost–benefit analysis, it is possible to determine an optimal combination.

301. Risk reduction, otherwise known as loss prevention, includes all activities that contribute towards diminishing the probability of losses. Retention in the context of risk management means that losses are absorbed by the capital of the economic agent at risk, either explicitly through a reserve fund or implicitly through a depletion of wealth at the time of the loss. It is possible to retain the risk across time by issuing debt in the financial markets at the time of loss and repaying the debt over time. Finally, risk transfer entails passing the risk to another economic agent for an exchange price, which is called the premium.

302. To implement each strategy, there is a broad range of financial instruments currently available in financial markets. Besides these, it is possible to structure innovative financial instruments, blending several together for a specific purpose, to suit the given risk profile, budget constraints and level of risk market development.

303. The theoretical framework of risk management came about in response to problems faced by the financial and insurance industries. In both industries, economic agents deal with uncertainty and how to reduce or prevent the loss of value. These techniques can support new developments for the different kinds of risk presented by climate change.

C. Assessing risk

304. Risk assessment is the first stage in designing a risk management strategy. The financial literature refers to risk as a variation or change in the value of assets. Although changes can be positive, this section will consider only negative changes in assets as a consequence of climate change.

305. As discussed in chapter III, assets do not have to be financial; assets can include agricultural harvests, livestock, infrastructure or intangible assets such as public services or even human life. Risk assessment should consider a range of assets, which would will be the basis of the financial risk management structure.

306. The risk assessment entails two main components of modelling hazard behaviour and modelling asset vulnerability (see figure 11). The first component concerns analysing their behaviour through mathematical models and estimating the probability of risk occurrence through historical and simulated events. The second component is a detailed analysis of pertinent assets exposed to risk and their vulnerability to different levels of hazard impact.

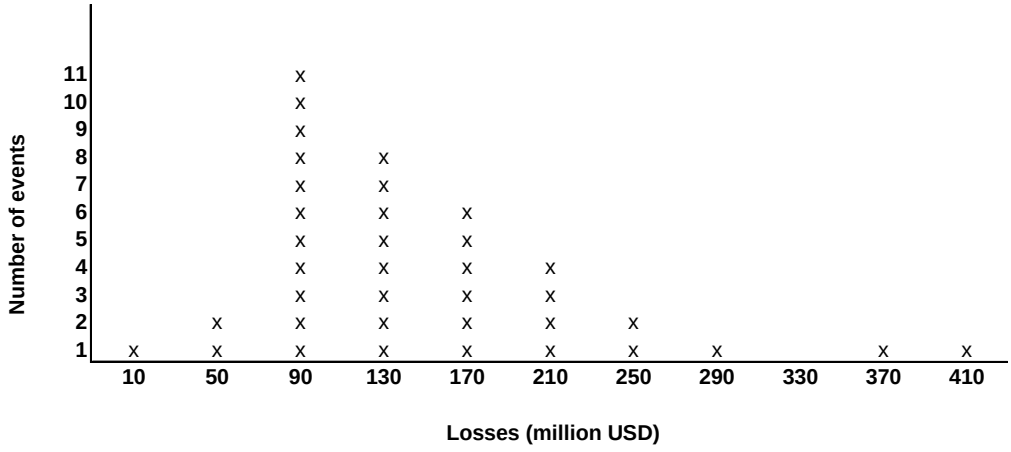
Figure 11. Components of risk assessment

Hazard assessment and modelling
+
Assets assessment and modelling
=
Losses estimation

307. To better understand the importance of risk assessment, consider the case of a hypothetical developing economy, in which there is a set of small corn producers and a natural hazard of heavy rainfall. According to the producer's experience, a rainfall event with precipitation of more than 200 millimetres generates a 100 per cent loss (i.e. a total loss). In this hypothetical country, in the last 50 years there are records of 37 rainfall events of 200 millimetres or more.

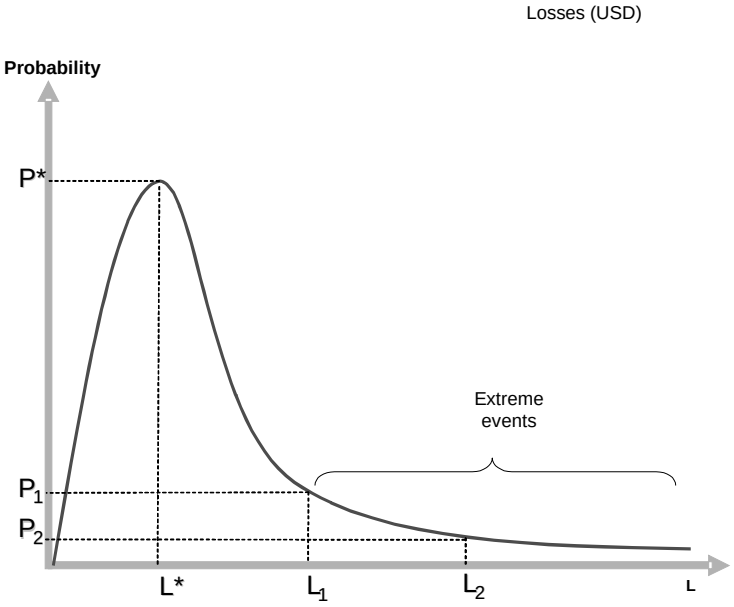
308. The losses associated with each of the 37 imaginary events are described in figure 12 in terms of frequency and amount of losses. In the figure, the horizontal axis displays the value of losses in millions of United States dollars and the vertical axis shows the frequency of rainfall events of 200 millimetres or more.

Figure 12. Example: frequency distribution of events



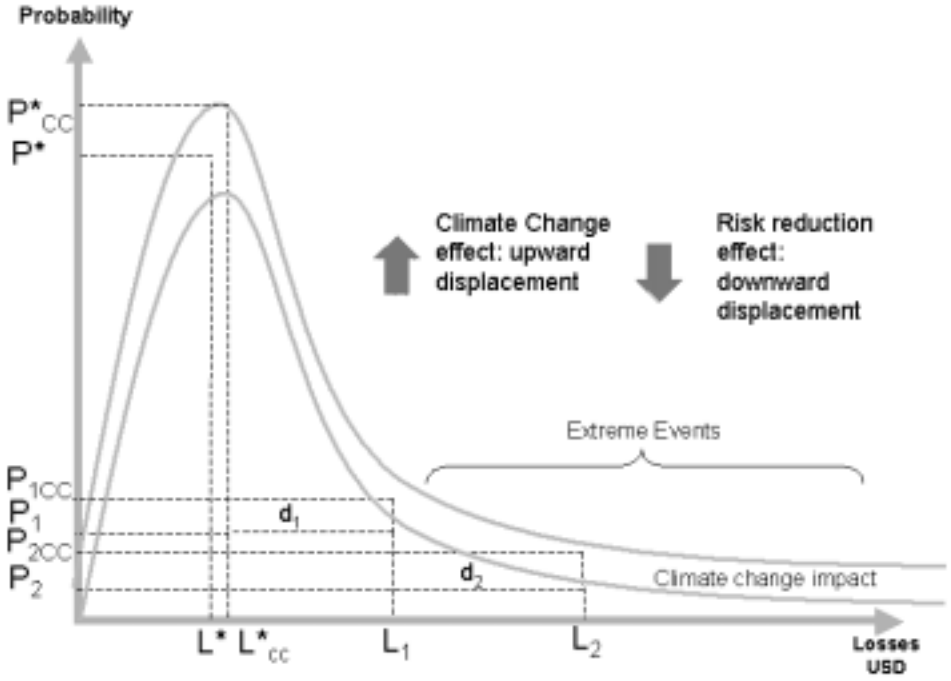
309. Similar plots can be created for other precipitation levels, to create formal statistical distributions of the losses. Figure 13 shows formally the relation between losses and the probability of the occurrence of an event. In the figure, the horizontal axis displays the losses L for each level of probability. The value L^* is defined as the value with the highest probability of occurrence. In simple situations L^* is also the average, or mean value, of the distribution of losses. There are lower probabilities associated with other lower or higher losses. In this figure the extreme values or catastrophes have high losses and low probabilities.

Figure 13. Example: probability distribution



310. The effect of climate change can be explained as changes in the probability distribution; some events that were infrequent are now frequent, while other events have become less frequent. Unfortunately, it is generally the costly events that have become more frequent. Figure 14 shows the effects of climate change in terms of losses and probabilities as an upward displacement from the bottom curve to a higher distribution of losses. This implies that for the high losses, the occurrence probability is higher, in consequence for any loss the *d* is higher, i.e. the risk is bigger.

Figure 14. Probability distribution with climate change impact



311. An important factor to emphasize in figure 14 is the dynamics of risk management in practice. Any increase in the assets exposed to the hazards will be reflected in a shift to the right of the occurrence probability curve, and an increase in the average expected loss. On the other hand, any risk reduction strategy would shift the curve to the left and so reduce the average loss.

312. Figure 14 can also provide more information about the potential risk management strategies that could be employed. For example, values close to L^* are frequent losses every year, therefore there is high certainty of their occurrence. An insurer would want a premium in excess of L^*, to cover his additional expenses due to losses over L^* occurring. For those cases, the risk should be retained and financed through savings or reserves because they can be budgeted for with reasonable certainty.

313. With regard to values above L^*, for example L_1 or L_2 (see figure 13), there are markets where third parties could take on the risk for a price significantly smaller than the losses. Unlike an individual corn producer, third parties can utilize the fact that the probability is small, and pool the risk with other low-frequency risks to achieve an acceptable level of certainty in the average loss that they have accepted from, say, a number of corn producers. The markets described here are the insurance and reinsurance markets and the capital markets.

314. The values of L_1 and L_2 are sums insured or liability limits. Typically, in the insurance industry, premiums are expressed as a ratio of the sum insured. This ratio is known as Rate on Line.

315. The fundamental requirements to develop a risk assessment are: data gathering; compilation; processing and analysis; and modelling asset vulnerability and hazard behaviour. FFrom the corn producer example above, the necessary inputs into the risk assessment would include models of how corn grows, including analysing the effect of water availability across a range of levels and analysing other effects such as temperature.

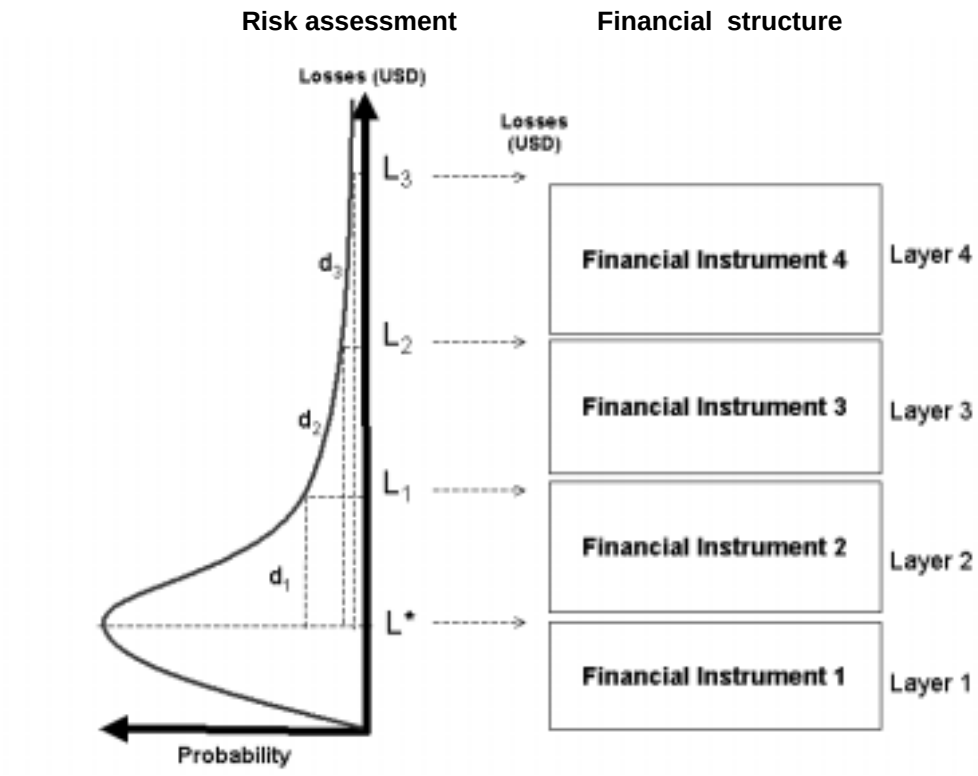
316. This section has outlined the importance of risk assessment for the structuring and implementation of risk management strategies. Typically, research centres, universities or modelling firms undertake the risk assessment. These firms, which include AIR Worldwide, Risk Management Solutions and EQECAT, are recognized by the international financial markets as independent experts in risk management.

D. Financial structuring of risk management

317. In order to explain the structuring process of a financial risk management strategy, it is assumed that there are enough data on the assets at risk, and that for each kind of asset there is a model that describes the asset's vulnerability to each hazard. It is also assumed that there are analytical models of hazards and that it is possible to analyse the interaction of assets and hazards and produce loss distributions. Various financial instruments are available for each risk management strategy.

318. The first step of the financial structuring is to divide the distribution of losses into layers. Each layer can be assigned to one or several instruments. Figure 15 shows the fusion of risk assessment and financial structuring. For example, the layer with larger certainty (probability of risk) around the statistical mean should be retained by the asset holder through a reserve fund or intertemporally through debt. The higher layers can be financed with insurance, derivatives (options and futures, among others) and catastrophe bonds. In some cases, higher layers have to be retained because the potential liability is too great to be insurable, particularly in the case of governmental losses, or because the cost–benefit relationship is unsatisfactory.

Figure 15. Risk management financial structure



319. An efficient risk management scheme entails assigning an instrument or set of instruments to each layer, consistent with the selected strategy (reduction, retention or transfer). There are cases where the lower layers (e.g. layers 1 and 2 in figure 15) are not assigned to instruments explicitly designed for the selected strategy, but may be combined, for example, in an insurance coverage with a large deductible.[170]

Generic financial instruments

320. Chapters IV and V discuss in detail the financial tools available for risk management. In generic terms the financial instruments used to explore innovative systems for handing climate change risk include:

(a) A reserve fund, which holds liquid capital to be used in the event of a disaster or frequent catastrophes and extreme events. Ideally, the fund accumulates in years without catastrophes. However, based on experience, there is considerable political risk of the fund being diverted for other pressing government needs in these years;

(b) Risk transfer, which provides indemnification against losses in exchange for a payment. The most common form of risk transfer is insurance or reinsurance. Insurance is an important pre-disaster tool that distributes disaster losses among a pool of at-risk households, businesses and/or governments and the reinsurance markets. With primary and reinsurance markets attracting capital from international investors, insurance has become an instrument for transferring disaster risks around the globe. In the early 1990s large losses from catastrophes in the United States strained the capacity of the

[170] The implicit instrument behind the larger deductible is that of retention, although there is no formal instrument such as reserves or a contingent line of credit. The insured party is assuming the risk of those layers by way of the deductible.

reinsurance markets and raised the price of reinsurance. This crisis led to the development of innovative financial instruments for transferring catastrophe risk exposures, including catastrophe bonds and other types of index-based securities that are traded on the capital markets. As explained in paragraphs 180–186 above, a catastrophe bond (cat bond) is an instrument whereby the investor receives an above-market return when a specific catastrophe does not occur (e.g. a hurricane of Category 4 or above), but shares the insurer's or government's losses by sacrificing interest or principal following the event;

(c) Contingent credit arrangements, which transfer risk over time rather than spatially. In exchange for an annual fee, the right is obtained to take out a pre-specified post-event loan that is repaid at contractually fixed conditions. In the case of sovereign risk financing, international finance institutions (IFIs) offer such instruments.

E. Potential financial schemes for developing economies

321. This section proposes financial schemes for developing countries, especially LDCs, SIDS and countries in Africa, focused on managing their climate change risks. These schemes have been developed for two types of economic agent: (1) the potentially affected population; and (2) the government as the public services provider. The implications and challenges for both economic agents will be discussed, particularly in the implementation of the schemes. The economic agents have different needs and risk profiles, but one important benefit of the current proposals is that they can manage their risks through a single mechanism, although its inherent risk profile differs depending on the agent.

322. Provision of access to the financial scheme at an affordable price for the population is a key challenge for financing losses incurred by the population, as low-income families are often in informal, hazardous locations that lack formal financial services. This presents an opportunity for NGOs and local communities, supported by multilateral organizations, to develop alternative distribution channels, as with microfinance. For simplicity, the population's losses will be defined here in terms of damage to two important asset groups: crops of small farmers and housing of low-income populations.

323. Government losses from climate change will be of two main types: (1) infrastructure and public assets; and (2) Liquidity used for emergency expenses. Although losses to infrastructure and public assets represent significantly greater costs to the government than the provision of emergency expenses, the latter meets an urgent need and so is worthy of attention. Once the public risks are quantified, traditional channels such as insurance companies could be vehicles to transfer risks to risk markets.

324. With both population and government losses, once the risks have been quantified independently and transferred directly or through an intermediary, the risks could be reinsured to the international financial markets, in a single insurance policy if appropriate.

325. Three schemes are outlined in this section. Scheme A is the simplest; it can be adopted with immediate effect, and can apply to single countries. Scheme B applies to a group of countries, but lacks a function to prevent significant losses. Scheme C can apply to a single country or a group of countries, and benefits from a central risk management function with a focus on loss prevention. The difference between a scheme for an individual country and a group of countries is the critical mass. A group provides countries with greater negotiation power in the financial markets, which is a particularly relevant factor for small economies, and can also substantially improve the risk profile by diversification across geographical regions, types of hazard and types of asset, all of which will improve the risk pricing.

326. All the schemes require strong external support to encourage their implementation and create the necessary conditions to develop the structures, coordinate local actors and engage the authorities. The aim of the schemes should be to create and develop local markets and through them provide market-based solutions for the sustainable growth of the participating nations. External support is needed

because there are not sufficient incentives for private actors to incur the overhead of market creation. However, once the market is created and developed, the aim should be to progressively phase out external support for insurable risks.

1. Scheme A: a single insurance policy by country

327. Scheme A would apply in a situation where the underlying risks are insurable, but the insurance market has not started up because of, for example, regulatory or informational barriers. It is the simplest scheme, can be adopted with immediate effect and applies to single countries. The aim of this scheme is to spread climate change risks. These should be quantified in the risk assessment phase, where the assets should be detailed, as well as the kinds of hazard involved.

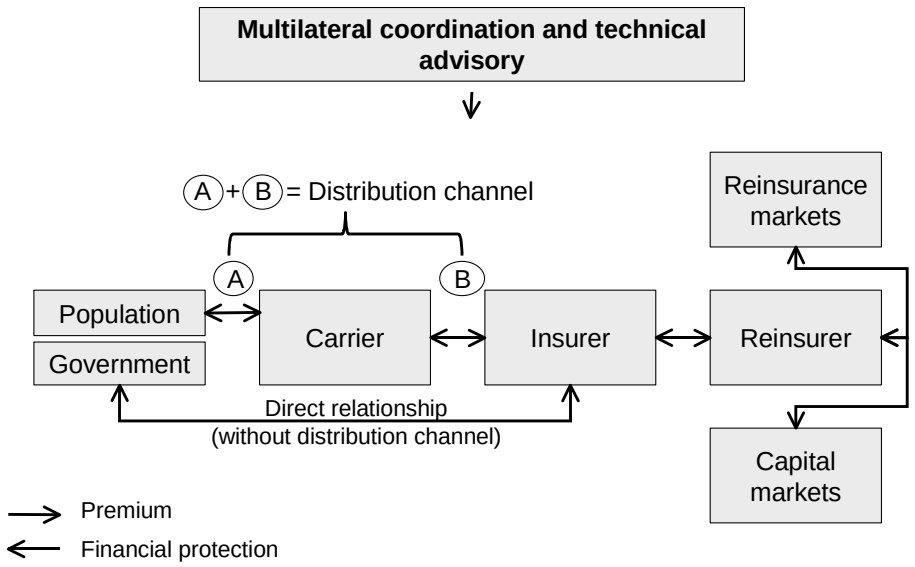
328. The scheme consists of removing the market barriers through external support (which may include database compilation, technical training, improved regulatory framework and financial risk management advice); and transferring as much risk as is feasible and efficient to the global reinsurance markets (see figures 16 (a) and (b)). The figure also identifies opportunities for multilateral support to develop markets and provide technical advice in risk management linked to climate change.

329. Under this scheme, the population (small farmers and low-income groups) and the government transfer their risk either directly to insurance companies, in the case of the government, or via intermediaries or channels such as local savings banks or local cooperatives, in the case of the population. The risks can subsequently be transferred to the reinsurance market as appropriate.

330. The scheme should transfer optimal amount of risk indicated by the risk assessment. In line with figure 15, scheme A assumes that the risk will be distributed by two instruments: insurance (risk-transfer) and implicit retention. The scheme does not require that the retained risk be concentrated in any particular format.

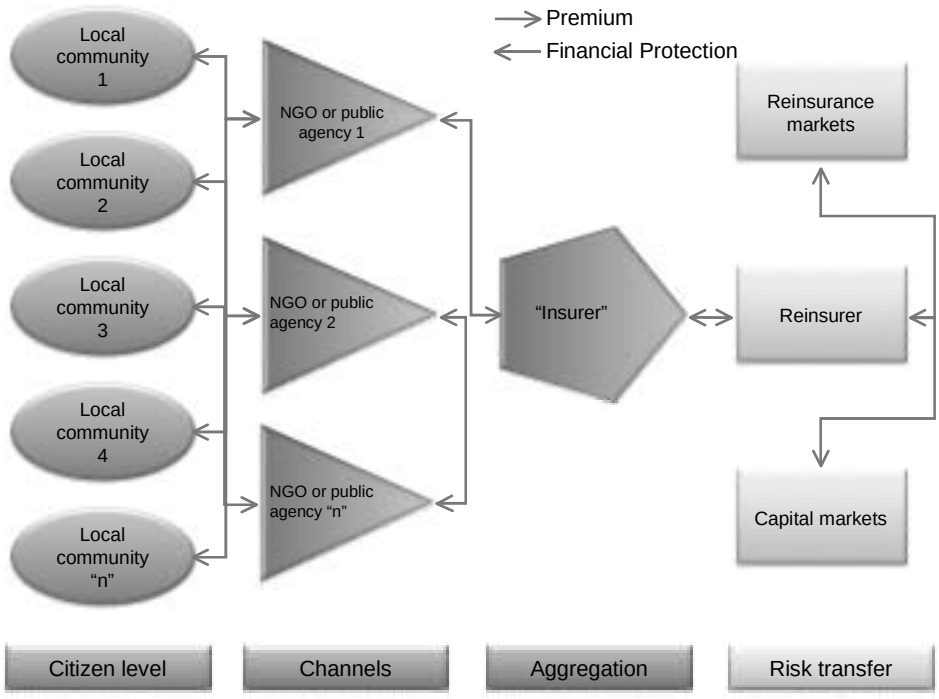
331. There is no explicit risk reduction programme for this scheme because it is a short-term scheme for immediate implementation. A risk reduction strategy will be considered for scheme C.

Figure 16 (a). Illustration of scheme A: single insurance policy for a single country



Example for one country

Figure 16 (b). Distribution channels



2. Scheme B: a single insurance policy for a set of countries

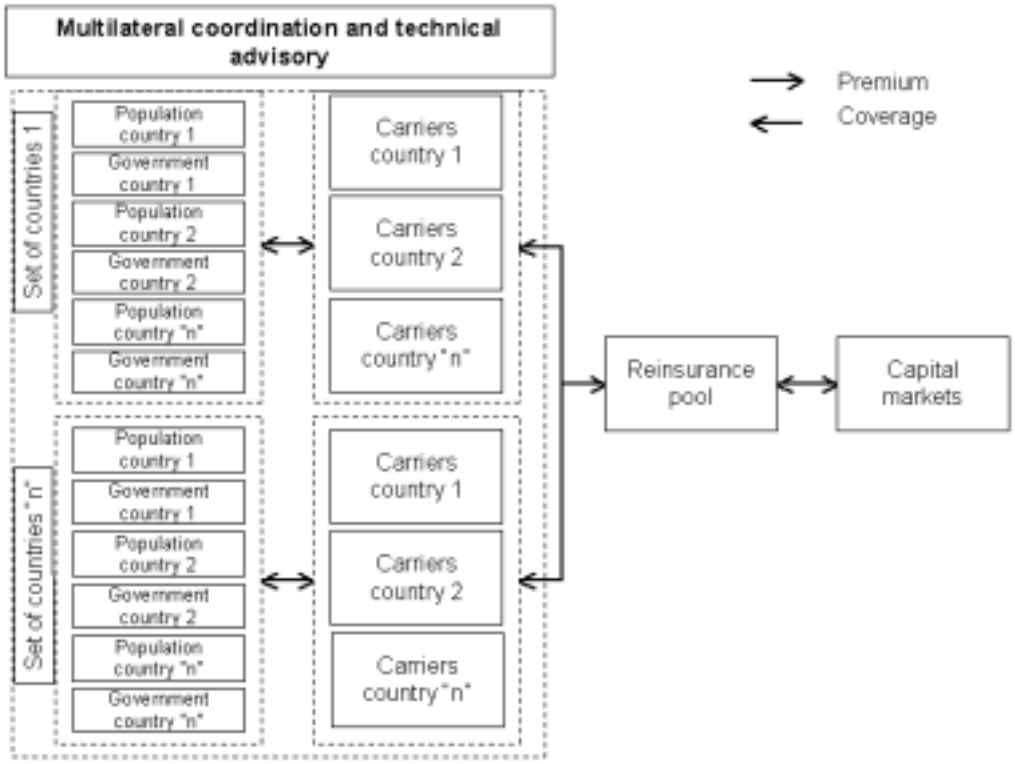
332. Scheme B requires the participation of several countries or sets of countries (e.g. LDCs, SIDS and countries in Africa). The channels are basically the same as for scheme A.

333. Scheme B applies to a situation where a group of countries has insurable risks, but the insurance market has not developed owing to various barriers. This scheme requires strong support by external entities, such as multilateral organizations and donors, to provide technical advice and coordinate the establishment of the scheme. One of the scheme's strengths is to diversify the risks geographically, by sector and by asset. It also creates a critical mass of negotiating power in the international financial markets.

334. In the simplest case, the risk is focused in a single reinsurance policy, shared through a reinsurance pool, which can thereafter transfer part of the risk to the reinsurance and capital markets. In practice, it is likely that some asset classes or policyholder groups will be insured independently from others for political and practical reasons.

335. Figure 17 shows the cash flow for the insured (flowing from left to right) whereby the premiums from the insured are transferred to the risk takers (reinsurers) through the channels (intermediaries). The cash flow for the risk taker flows from right to left in the figure. This kind of financial structure typically works for one year and then needs to be renegotiated annually.

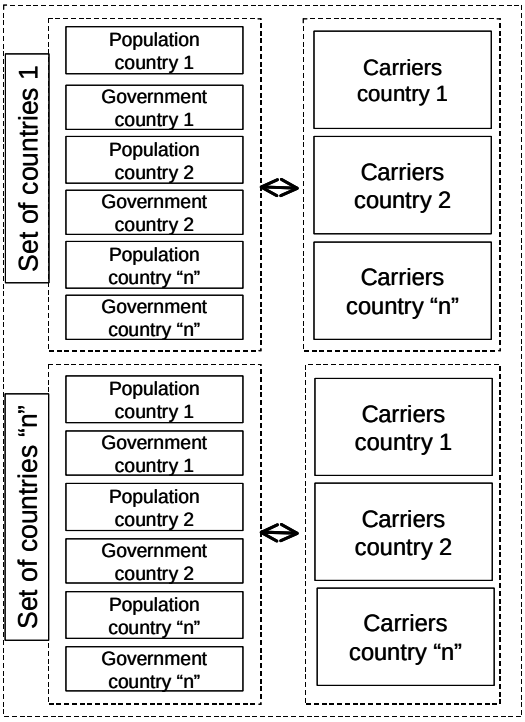
Figure 17. Illustration of scheme B: single insurance policy for a set of countries



3. Scheme C: a climate change risk management mechanism

336. Scheme C introduces the main initiative of this chapter: a climate change risk management mechanism (figure 19). The aim of the mechanism is to provide market solutions, stimulate efficient risk management, focus efforts to prepare for the adverse effects of climate change and transfer the risk to international markets. In particular, this initiative proposes coordination of international support to create a global solution for local problems, especially in LDCs, SIDS and countries in Africa, where the underlying risks may be uninsurable (probably because of the high degree of hazard or the inability of the parties at risk to pay an adequate premium). The scheme is designed for governments and populations of those countries affected by climate change, but depends heavily on support from the international community.

Figure 18. Risk pooling



337. In scheme C, as with schemes A and B, the participating country will manage risk associated with population losses (crops of small farmers and housing of low-income groups) and government losses (infrastructure and liquidity for emergency expenses). The intermediaries/channels (figure 18) for the population should be local actors (cooperatives). In some countries, specialized financial institutions such as insurance companies can act as intermediaries to the financial markets. For population losses – that is, losses at the citizen level – intermediaries are important elements; local communities should be encouraged to organize themselves to transfer risk to financial markets. Local governments, multilateral organizations and NGOs could support this effort to transfer the risk to the mechanism proposed in scheme C.

338. The mechanism has two fundamental components. The first component is a technical advisory facility created to provide technical advice to the countries on risk management techniques in the context of climate change. The facility advises on financial subjects and physical modelling of the risk. It is the backbone of the risk management strategy for each set of countries and the link with multilateral support entities and risk reduction (loss prevention) agencies.

339. The second component is a financial vehicle. The financial vehicle administers two sub-components:

(a) A 'responsibility fund' that accumulates resources in order to retain risk. This reserve fund allows for the assumption of frequent risks by those insured. In terms of figure 15, the first layers will be handled by the reserve fund. Among other sources, the responsibility fund can receive financial resources provided by industrialized countries to assist developing countries under the Convention;

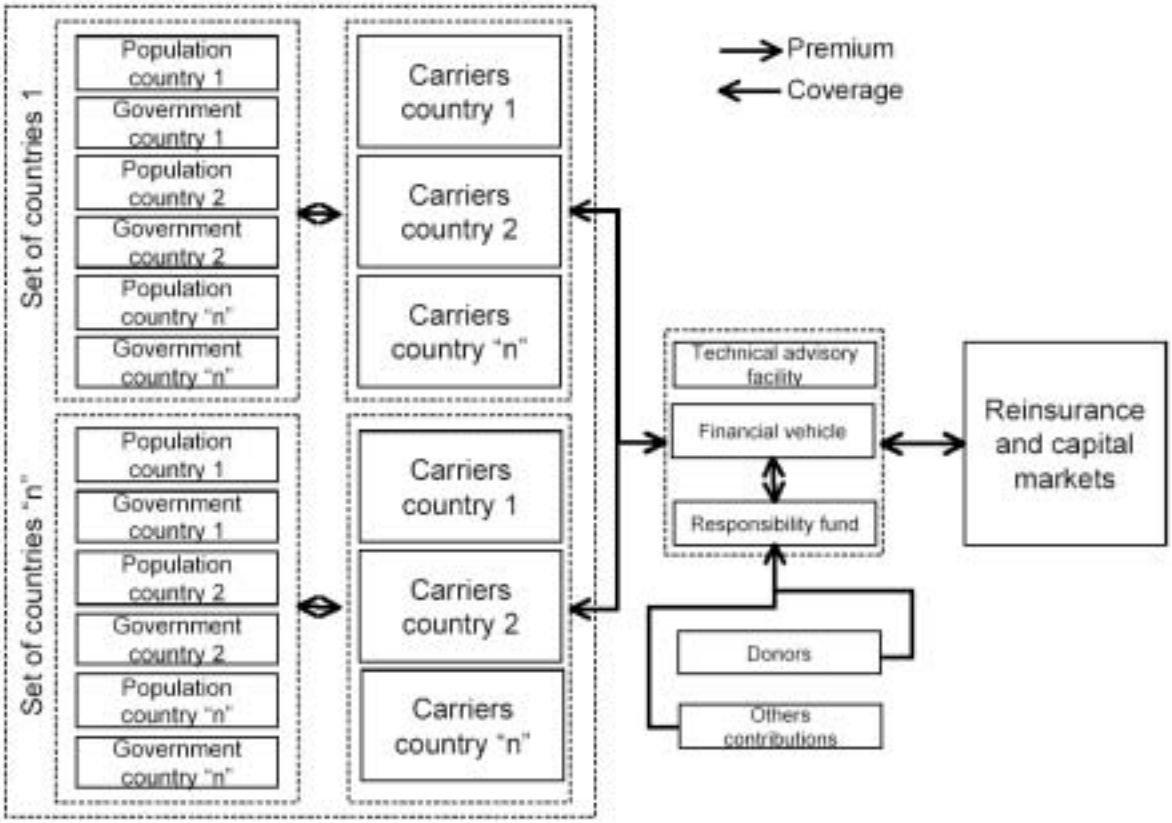
(b) Premiums from those countries that decide to have reinsurance coverage through the financial vehicle. The vehicle is not a substitute for the reinsurance and capital markets, but a channel to them.

340. The countries have the freedom to transfer risk through the financial vehicle or transfer it to any other reinsurer. Nevertheless, in the latter case the countries do not have access to the responsibility fund and the only benefit for them is the technical advisory facility.

341. The reserves of the mechanism are a fundamental sub-component. Through this reserve fund, countries can obtain better premiums and greater coverage. In the context of figure 15, the risky part of the loss distribution is assumed by the reserve fund.

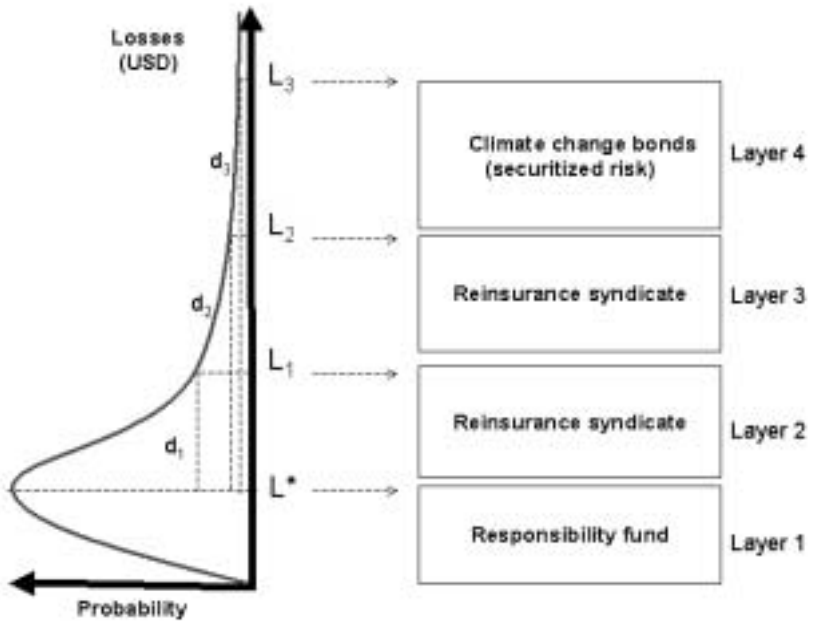
342. Scheme C concentrates international efforts by way of a serving as a global promoter and adviser of risk management for parties, stimulating market-based solutions and transparency in resource spending. It motivates risk reduction in the affected parties, and subsidizes retrofitting efforts through a special section in the reserve fund of the mechanism (figure 19).

Figure 19. Illustration of scheme C: climate change risk management mechanism



343. Figure 20 shows a hypothetical distribution of financial instruments that could be used in scheme C; the actual mix would depend on the risk assessment and the market conditions in the reinsurance and capital markets.

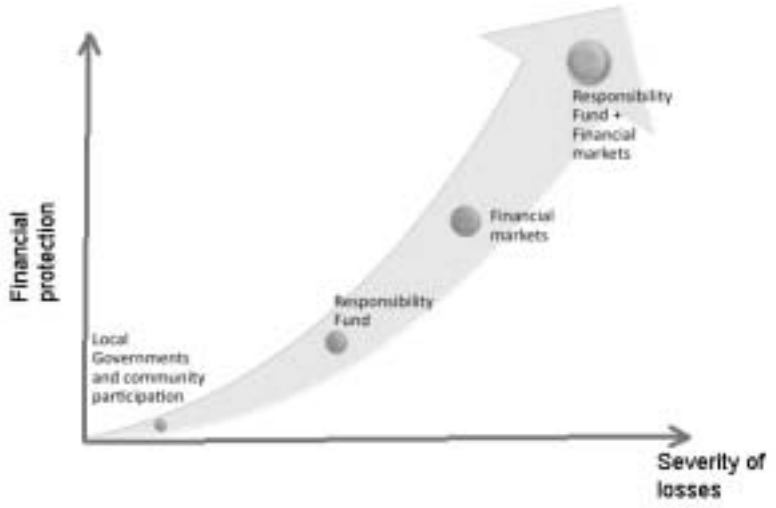
Figure 20. Example of a possible combination of financial instruments



344. The global effort involved in all three schemes merges the responsibility of industrialized countries, financial markets, local communities and governments into a single collective risk management strategy, with a clear goal to reduce and manage risks and losses.

345. Figure 21 illustrates the sequential nature of participation in risk financing. For a small part of the losses, participation is required by local communities and local governments in order to secure their commitment to the system. The responsibility fund of scheme C would cover large losses, both frequent and infrequent. This would enable high levels of risk retention and therefore lower premiums.

Figure 21. Operation of scheme C



346. The proposed level of risk retention makes scheme C attainable for low-income communities. A part of the risk of infrequent losses could be transferred to financial markets. In some cases financial markets on their own may not provide capacity for very high losses and so such losses, or very rare events, would be covered jointly through the responsibility fund and by financial markets.

347. The three schemes, in particular scheme C, are based on the assumption of global coordination, with political leadership. Market mechanisms by themselves cannot provide a solution to countries where markets are small or difficult to establish. Certainly financial markets are crucial players particularly in scheme C, and they can play a global role in spreading risks and providing technical coordination.

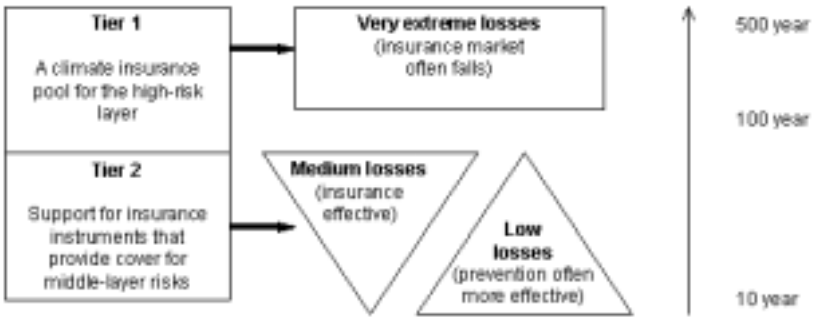
348. The Munich Climate Insurance Initiative (MCII) has recently made an independent but similar proposal to that proposed in this section that meets the challenge of providing support to promote sustainable, affordable and incentive-compatible insurance programmes for vulnerable households, small and medium enterprises (SMEs) and governments in the developing world, and at the same time enabling private sector involvement (box 8). Because of the substantial economies of scale arising from pooling public- and private-sector risks, there are strong arguments for creating facilities, such as the Tier 1 climate insurance pool (CIP), at the global or regional level. The CIP would, in turn, be reinsured by the private markets. For those risks not covered by the CIP, there are strong arguments for enabling index-based and other microinsurance initiatives that have recently proved their capacity to serve the poor.

Box 8. The Munich Climate Insurance Initiative proposal for including insurance mechanisms in a post-Kyoto Protocol adaptation strategy

The Munich Climate Insurance Initiative (MCII) has proposed a two-pillar international risk-management programme as part of a future adaptation regime – fully financed by developed country Parties (see figure below). A risk prevention pillar would directly support risk-reduction measures. A two-tiered insurance pillar would address high- and medium-layers of risk.

The first tier takes the form of a climate insurance pool, which indemnifies victims of extreme catastrophes in non-Annex I Parties by a percentage of their losses. A second tier addresses medium-level risks not covered by Tier 1. This second tier takes the form of a climate insurance assistance facility that enables micro- and national insurance systems in vulnerable developing countries by providing technical assistance, capacity-building and possibly absorbing a portion of the insurance costs. Low-level risks are more effectively dealt with by preventive measures.

The Munich Climate Insurance Initiative proposal for climate insurance



By clarifying the opportunities and challenges of insurance as an instrument for adaptation, and outlining a practical way forward, it is hoped that this proposal may contribute to negotiations at the United Nations Climate Change Conference in Copenhagen in 2009 on a comprehensive adaptation strategy that enables risk management and insurance through the funding of a global adaptation strategy. More information on this proposal can be found at <http://unfccc.int/resource/docs/2008/smsn/ngo/019.pdf>.

F. Roles involved in implementing the proposed financial schemes for developing economies

1. Private sector

349. The private sector plays an essential role in risk financing. The following are the main duties that the private sector can perform:

(a) Risk-taking (through insurance or reinsurance or as an investor in the capital markets);

(b) Risk channelling (intermediaries);

(c) Providing and developing financial engineering techniques;

(d) Diversifying globally (as a reinsurer and investor).

350. As a risk-taker, the private sector assumes risks from other economic agents, allowing them to manage optimal levels of risk in their own risk portfolios. In this way, the economy in general reaches a higher economic welfare level.

351. Many of the financial tools for risk financing began life in the insurance and reinsurance industry.[171] In this sense, the private sector is the main developer of innovative financial technology. This makes it an excellent candidate for public–private partnerships, especially because the private sector has expertise and knowledge of other industries and sectors.

352. Finally, the private sector (reinsurers and capital markets investors) provides access to global diversified portfolios. This allows better pricing.

2. Government

353. The literature on risk management[172] has described the various roles of governments, including: manager of its own risks, insurer of last resort, and risk market maker. Owing to differences in the degree of development of national economies and the depth of financial markets, one government could be more active than another in these three areas.

354. The CCRIF scheme developed by the World Bank in the Caribbean (see paras. 289–291 above) was designed to support governments in their role of manager of their own risks by providing liquidity to governments after natural disasters more quickly than other financing sources. Similar examples were developed for the Governments of Mexico and Ethiopia (for example, in a scheme designed by the World Food Programme through an insurance company, the insurance would provide financial resources after a catastrophic drought and mitigate the ensuing famine).

355. Citizens of many countries, particularly in less developed economies, implicitly assume that as part of its role in risk management as insurer of last resort, their government will provide not only public services in extreme circumstances, but also resources for reconstruction of private assets such as housing or for meeting the cost of business interruption in private companies. However, this is unlikely to be the most efficient source of such resources. An example of a more efficient risk management strategy is the Turkish Catastrophe Insurance Pool. The scheme is fed by a premium in a mandatory insurance scheme for all households in the country. The scheme was developed for earthquakes, and the resources collected through the premium are sufficient to cover the losses. Only in extreme circumstances does the Government provide additional resources to guarantee the solvency of the insurance industry.

356. In their third role, governments also promote the development of the local risk markets, typically in the form of insurance companies. Many of the success stories are in agricultural and livestock

[171] Dionne, 2001.
[172] Gurenko, 2004.

insurance. For example, Malawi, Mexico and Mongolia have all developed schemes to provide insurance for small producers. Microinsurance has proved to be an important tool for low-income communities with limited access to financial instruments. Typically, these communities use a single tool of risk management, such as retention, often because of a lack of choice, and this tool is economically inefficient. Another initiative in this area is the Global Index Reinsurance Facility, developed by the World Bank and PartnerRe, a private insurance company. This initiative aims to provides market solutions for developing economies through parametric insurance schemes.

3. Bilateral and multilateral cooperation

357. Many developing economies, and particularly LDCs, SIDS and countries in Africa, lack capital, which limits the development of innovative financial schemes. Their financial markets are generally still under development, and redirecting public resources from critical priorities (health, education and food security, among others) into risk assessment and risk management could be complicated by social and political factors inside the countries. These conditions create vicious cycles of poverty and wealth damage that are aggravated by the effects of climate change and natural disasters, both of which increase losses, injuries and deaths.

358. In this context, international support is fundamental, provided by governments and NGOs that seek to promote sustainable development in developing economies. Such support can stimulate the development of human capital and markets and can break the vicious cycles to create virtuous cycles.

359. There are three ways in which entities can provide support: (1) provide or finance technical advisory services for assessing risks; (2) create market solutions and promote markets; and (3) incentivize risk reduction strategies. In this last case, there is an investment component, for example by retrofitting buildings and infrastructure that could help to reduce the potential losses after risk events. In Mexico and Central America it has been generally found that the cost–benefit relationship is around 4:1,[173] that is, each dollar spent in retrofitting and reinforcement implies four dollars of savings. For example, spending 100 dollars on a building in a hurricane zone, without investment in risk reduction, would imply a cost of 100 dollars, but if ten dollars of that were invested in retrofitting and reinforcement, it implies a cost of 60 dollars, achieving 40 dollars in savings.

360. Investment in risk assessment and risk reduction provides an efficient way to help nations in their sustainable development, particularly where there are no incentives from the markets to provide solutions.

G. Addressing potential challenges in the application of insurance schemes to the climate change context: parametric all-risk insurance

361. Climate change impacts could cause major harm to critical sectors of the economies of developing countries, such as to agriculture and fishing; to infrastructure, particularly through storm and water damage; and to human health and livelihoods. However, scientific techniques are currently unable to predict in detail the degree of these impacts or when they will occur. Indeed, one of the key messages from climate change science is to expect surprises.

362. In some cases it is not possible to specify at what level a cumulative change will become harmful. For example, the effects of steadily rising temperatures or saline levels on crop yield are modified by other factors, and laboratory conditions cannot mimic field conditions perfectly. This raises problems with some of the financial instruments that have been suggested for coping with the impacts of climate change, such as cat bonds and weather derivatives.

[173] Bitran, 2001.

363. Cat bonds and weather derivatives are finely tuned to the expected critical threshold of climatic parameters such as rainfall, drought or wind speed, in the expectation that when that threshold is exceeded, there will generally be damage to the key economic sectors. The implication is that when the threshold is not exceeded, the economy will perform adequately. The early experience with CCRIF has cast some doubt on this highly specified approach. Moreover, if in fact damage arises from an unexpected source, as seems quite possible, then no compensation will be payable. Again, if the critical impact is from a cumulative, gradual change then a 'threshold' approach based on extreme values of rainfall or wind speed, for example, may not mirror the impacts. For some locations, there may not be sufficient historical data on extreme events to specify a parametric risk-transfer instrument.

364. All-risks parametric insurance may be able to deal with slow-onset hazards and minimize basis risk due to climate change.

1. All-risk cover insurance

365. The growth of all-risk coverage in general insurance (i.e. property/casualty or non-life) provides a useful concept. Rather than the insurer trying to define exactly what the circumstances of a situation causing a loss might be, these contracts apply whenever a loss occurs, except for a very few prescribed exceptions, such as radiation. This avoids compensation not being paid because the causation is in doubt or the cause of loss is unprecedented. Premiums for such contracts are of course higher than for conventional specified-risk policies, and usually feature significant deductibles to avoid minor claims for miscellaneous incidents. However, these contracts still require the policyholder to prove his or her loss, so claims adjustment is still necessary.

2. A parametric 'all-risk' concept

366. Parametric triggers have been described earlier in this document. Despite the problem of basis risk, they have many practical advantages. The key lies in finding a parameter that captures the progress of climate change in the geographical area concerned. For most countries, it is likely that annual temperature is a good indicator of climate change. For islands, where the surrounding waters moderate the land temperature, it may be that change in sea level is a better indicator of climate change. This has the merit of simplicity, but would need to be reviewed for adequacy before being adopted.

3. Defining the trigger and compensation

367. The climate change parameter (e.g. annual temperature) can be expected to progress steadily upwards over time, although there may be short periods of regression due to inter-annual variability or exogenous factors such as volcanic eruption. It is therefore likely that the trigger would be the annual change in the climate change parameter.

368. Arriving at the compensation payable from changes in the trigger variable would have to be based on a process of consultation with stakeholders and experts. The intention of the insurance scheme would be to capture a range of possibilities in which harm to the economy might arise.

4. Inevitable loss

369. Some economies may be untenable in the long term because of climate change, for example those in certain small island States or those based on Arctic hunting. The all-risk concept could, if suitably calibrated, provide a way to transfer sufficient funds so that an alternative economic and even geographical configuration for these economies could be planned, financed and established over a period of years. This all-risk concept insurance scheme could be compared to a life and pensions insurance, where funds are accumulated over a long period. On the other hand, schemes involving disaster financing can be compared to property insurance and reinsurance.

5. Risk management

370. As with other parametric instruments, there is no incentive for the policyholder to engage in risky behaviour, since the compensation payable will not increase if the losses increase. In fact, the reverse applies: if the policyholder reduces the risk, there will be a margin of compensation available for additional economic development, over and above restoring any climatic damage.

371. Risk assessment is important for the structuring and implementation of risk management strategies. Typically, research centres, universities or modelling firms undertake the risk assessment. These firms, which include AIR Worldwide, Risk Management Solutions and EQECAT, are recognized by the international financial markets as independent experts in risk management.

H. Conclusions

372. This chapter proposed some novel financial schemes for developing countries, especially LDCs, SIDS and countries in Africa, focused on managing their climate change risks. These schemes have been developed for two types of economic agent: (1) the potentially affected population; and (2) the government as the public services provider. An important benefit of the current proposals is that the economic agents can manage their risks through a single mechanism, although the inherent risk profile differs depending on the agent.

373. All the schemes require strong external support to encourage their implementation and create the necessary conditions to develop the structures, coordinate local actors and engage the authorities. The aim of the schemes should be to create and develop local markets and through them provide market-based solutions for the sustainable growth of the participating nations. External support is needed because there are not sufficient incentives for private actors to incur the overhead of market creation. However, once the market is created and developed, the aim should be to progressively phase out external support for insurable risks.

374. The three schemes, in particular scheme C, are based on the assumption of global coordination, with political leadership. Market mechanisms by themselves cannot provide a solution to countries where markets are small or difficult to establish. Certainly financial markets are crucial players particularly in scheme C, and they can play a global role in spreading risks and providing technical coordination.

375. The Munich Climate Insurance Initiative (MCII) has recently made an independent but similar proposal to that proposed in this section that meets the challenge of providing support to promote sustainable, affordable and incentive-compatible insurance programmes for vulnerable households, SMEs and governments in the developing world, and at the same time enabling private sector involvement.

376. Investment in risk assessment and risk reduction provides an efficient way to help nations in their sustainable development, particularly where there are no incentives from the markets to provide solutions. There are three ways in which entities can provide support: (1) provide or finance technical advisory services for assessing risks; (2) create market solutions and promote markets; and (3) incentivize risk reduction strategies. In this last case, there is an investment component, for example by retrofitting buildings and infrastructure that could help to reduce the potential losses.

377. All-risks parametric insurance is one way in which risk can be reduced from slow-onset hazards. This type of insurance can also minimize basis risk due to climate change.

VI. Non-insurance mechanisms for managing climate-related risks

A. Introduction

378. This chapter reviews financial mechanisms other than insurance (non-insurance mechanisms) for coping with climate variability and extremes in highly vulnerable developing countries, and for providing the necessary capital to finance a range of climate adaptation measures. Options are suggested for non-insurance instruments alongside insurance mechanisms that can be part of adaptation provisions in a future climate change regime, and can input into discussions at the fifteenth session of the Conference of the Parties (COP).

379. Traditionally, individuals, households and SMEs in developing countries have, in the absence of insurance, employed diverse financial strategies for coping with climate and weather variability and extremes. These include: savings or mutual arrangements with family and neighbours; loans from family, micro-credit institutions or money lenders; or, in emergencies, selling or mortgaging assets and land if they cannot rely on government relief or international assistance. Governments of countries with high likelihood of risk have also relied on a range of financial approaches to meet their post-disaster liabilities, such as diverting funds from other budgeted programmes, borrowing money domestically or securing loans from international financial institutions. Conventional financial arrangements can fall short of post-disaster capital needs, and this gap is likely to widen with more intense and frequent climate-related disasters. To close the gap, some governments are experimenting with capital market and hedging instruments (insurance-related securities) such as catastrophe bonds, risk swaps and options.

380. As a pre-disaster instrument, insurance provides security against the loss of assets and livelihoods in the post-disaster period. It ensures reliable and dignified post-disaster relief, can be designed to set powerful incentives for prevention, and not least, provides a safety net for innovative risk-taking, which is essential for development and for achieving climate resilience. However, insurance is not a direct financing mechanism for pre-event adaptation measures, such as switching to less vulnerable crops and livelihoods, using more resilient housing design, or investing in filters against salt water intrusion. Many non-insurance mechanisms discussed in this chapter, such as remittances and credit arrangements, can serve this purpose.

381. Another distinction between different types of mechanism concerns responsibility, or 'who pays' for climate adaptation. Financial instruments are not neutral in this regard. Insurance (if not supported by external funding) places the responsibility on those at risk, although it spreads this responsibility through pooling arrangements and lightens the burden of disaster by reducing financial losses faced by those affected. The same is true for many non-insurance mechanisms, such as microfinance. Critics are concerned that these instruments shift responsibility from social institutions to the poor. Other financial instruments, such as remittances or catastrophe reserve funds, redistribute the liability from the victim community, for example, to families or tax payers.

382. In a narrow sense, when insurance is used, the potential victims pay premiums greater than their annual expected losses to cover administrative and other costs. However, advocates of insurance point out that by spreading risk, it enables wealth creation, so that the result is not a net outflow of funds but an increase, owing to the need for a smaller disaster reserve when risks are pooled, and more confident investment and entrepreneurial activity.[174]

383. The opportunity and challenge for a future adaptation strategy is to find a middle way between solidarity and market liability by providing funding that offers the advantages of market instruments but can be made available to, and affordable for, the most vulnerable.

[174] UNEPFI, 2007.

384. Consideration of non-insurance mechanisms is important, not only because Parties can make use of a diverse portfolio of financial instruments in adapting to climate change, but also because in some contexts these may offer less costly alternatives to insurance instruments for financing climate-related risks. However, it must be noted that non-insurance financing approaches have not yet been able to meet the needs of developing countries in reducing their exposure to climate risks and providing timely capital for disaster reconstruction and adaptation measures. The following aspects are included in this chapter:

(a) Section B the describes the range of mechanisms and arrangements that can be called upon by households, governments and intermediary institutions, among others, for financing climate-related risks and investments in adaptation;

(b) Sections C, D and E review non-insurance instruments and their relevance to climate adaptation at the micro, meso and macro scale, respectively, emphasizing how the instruments distribute the adaptation financial burden;

(c) In section F, the costs and benefits of insurance and non-insurance instruments are compared;

(d) Section G considers how non-insurance mechanisms can form part of an adaptation strategy.

B. The range of mechanisms for managing climate-related risks

385. The range of financial mechanisms available for managing climate-related risks is illustrated in table 11, which includes examples of formal and informal mechanisms for agents operating at different scales: households and SMEs operating at the micro scale; microfinance institutions, donor organizations and others operating at the meso scale; and governments as macro-scale operators. One of the most common strategies for coping with weather disasters is collective loss sharing, which may involve government assistance, humanitarian aid and other common forms of domestic and international solidarity. Solidarity can also take the form of mutual arrangements among family or community members, referred to in this document as informal risk-sharing. The large flow of remittances, for example from family members overseas, is an example of this type of informal financial mechanism. Alternatively, or in addition, households may save cash or ensure the availability of fungible assets to provide them with capital for investments in adaptation and for post-disaster relief; or they can make pre- or post-disaster credit arrangements for these same purposes. Governments also save, by creating catastrophe reserve funds for example. Savings, credit arrangements and reserve funds are all forms of intertemporal risk spreading, since they provide resources or require payments at some time in the future.

386. While non-insurance mechanisms can provide, as insurance does, the liquidity needed for recovering from disaster shocks, they can also provide capital for pre-event adaptation investments. Unlike insurance, they do not put a price on risk and thus appear not to give signals or incentives for pre-event risk reduction. However, in practice the terms on which finance is available, or even its unavailability, may reflect the degree of hazard that is present. Also, many of these mechanisms can in principle be designed to encourage risk management strategies.

387. The instruments shown in table 11 do not always stand alone, but often work in combination as hubrids, as in the case of the bundled insurance-loan package for Malawian farmers (see paras. 242–247 above).

Table 11. Examples of insurance and non-insurance mechanisms for managing risks

Mechanism	Micro scale risk financing Households, small and medium enterprises, farms	Meso scale risk financing Financial institutions, donor organizations, etc.	Macro scale risk financing Governments
Non-insurance mechanisms			
Informal risk sharing	Kinship and other mutual arrangements, remittances (family and community solidarity)		Diversions from other budgeted programmes
Intertemporal risk spreading	Microsavings, microcredit, fungible assets, food storage (individual responsibility)	Emergency liquidity funds	Reserve funds, regional pools and post-disaster credit, contingent credit
Collective loss sharing (solidarity)	Post-disaster government assistance, humanitarian aid (national and international solidarity)	Government guarantees and bailouts	Bilateral and multilateral assistance
Insurance mechanisms			
Risk pooling and transfer, insurance	Microinsurance, insurance, weather hedges (individual responsibility)	Reinsurance	Sovereign risk financing, regional catastrophe insurance pools
Alternative risk transfer		Catastrophe bonds	Catastrophe bonds; risk swaps, options and loss warranties

C. Non-insurance risk-financing mechanisms at the micro scale

388. Despite the promise of insurance schemes to provide tools for managing risks, they cannot be a panacea for households, SMEs and other 'micro agents' in adapting to climate change. There are many reasons for this, including:

(a) Conventional insurance is generally not appropriate for very slow-onset climate impacts, such as sea level rise and desertification. Other instruments may be needed in this case;

(b) Insurance cannot finance preemptive or anticipatory adaptation measures (although it can be used as a precondition for adaptive funding);

(c) The opportunity costs of setting up self-financing risk-transfer instruments in some of the most vulnerable countries, including the LDCs, may be considered high in terms of meeting other human needs;

(d) Many developing countries lack an insurance culture and an insurance market, which will take time to develop.

389. Different financing mechanisms will be needed for adaptation. The remainder of this section reviews non-insurance instruments that operate at a micro scale.

1. Informal risk sharing

390. Victims of climate and weather variability and extremes in developing countries rely extensively on financial arrangements that involve reciprocal exchange, kinship ties and community self help. Women in high-risk areas, for example, often access post-disaster capital by joining informal risk-hedging schemes, becoming clients of multiple microfinance institutions, or maintaining reciprocal social

relationships. These same strategies can provide financial resources for adaptation by facilitating credit for such measures as rain collection facilities or moving out of highly exposed areas. Beyond sharing financial resources, whether through self-organized pools of resources, exchanges or loans, households use informal networks to protect livelihood processes.[175] Cohen and Sebstad claim that these risk-sharing arrangements work reasonably well for less severe and idiosyncratic[176] shocks, but have limited scope for co-variant or systemic shocks that affect entire risk-sharing communities.[177] To hedge against co-variant[178] risks, households may relocate family members and rely on remittances, or diversify their livelihoods.

391. Reciprocal arrangements, including remittances, spread risks spatially and might be considered a precursor of formal market pooling or insurance arrangements. Pooling generally retains the risks and responsibilities within the victim communities and their families. 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.[179] Local informal risk sharing is inherently restricted, by limited resources and diversification opportunities. Financing arrangements with wider geographic diversification through migration and remittances, as reviewed in paragraphs. 392–395 below, are better able to manage large-scale risks.

Remittances

392. Remittances, or transfers of money from foreign workers to their home countries, are substantial throughout the developing world, even exceeding official development assistance. In 2006, the official worldwide flow of remittances was estimated at USD 268 million, and unrecorded flows through informal channels may add another 50 per cent or more.[180] In some cases, total remittances can be as large as a third of the recipient country's GDP.[181]

393. Remittances serve mainly as an additional source of income, and, as such, they can reduce poverty and contribute to climate resilience. Remittances are also hugely important for disaster relief, often exceeding post-disaster donor assistance. This was demonstrated recently by the large remittance flows to victims of the 2005 Pakistan earthquake, which yielded important insights for aid organizations that would like to establish a greater role for remittances in disaster prevention and recovery.

394. Payments can be sent through formal means such as banks or professional money transfer organizations, but often these channels break down and remittances are carried by hand.[182] While remittances are simple in concept, their use can be complicated by associated transfer fees. A survey carried out in the United Kingdom found that for an average-sized transfer, the associated costs could vary between 2.5 per cent and 40 per cent (DFID, 2005).[183] Information on transfers 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. Finally, remittance transfers across some borders have been complicated by initiatives taken by developed nations to counter international money laundering and financing of terrorism.[184] Owing to

[175] Cox and Fafchamps, 2007.
[176] Idiosyncratic is defined as micro-level shocks, as experienced by individuals or single families or firms.
[177] Cohen and Sebstad, 2003.
[178] Co-variant risk is defined as risk affecting many individuals, families or firms at the same time.
[179] Cox and Fafchamps, 2007.
[180] Mohapatra et al., 2006.
[181] World Bank, 2008a
[182] Savage and Harvey, 2007.
[183] IDB, 2007.
[184] Fagen and Bump, 2006

stricter enforcement of immigration laws and a crackdown on illegal immigrants, remittance growth dropped to 6 per cent in the first half of 2007, compared with 23 per cent in the same period in 2006.[185]

395. A major problem facing disaster victims is difficulties in communicating with relatives abroad, and the subsequent inability to request aid. Some non-profit organizations disburse pre-paid mobile phones to the affected population after a disaster for this purpose. This, and other options for enabling more effective remittance flows as part of an adaptation strategy.

2. Intertemporal risk spreading: microsavings and microcredit

Microsavings

396. Literally saving for a rainy day, microsaving might be considered the most obvious and self-sufficient financial management mechanism for climate-related weather variability and extremes. In contrast to insurance, which spreads risk spatially, savings spread risk temporally. Both place responsibility on the individuals at risk. Current income of the poor is rarely sufficient for them to manage crises or to invest when an opportunity for climate adaptation appears.[186] Saving can enable climate adaptation by accumulating necessary capital or collateral for future adaptation investments. Besides setting aside money, saving can be in the form of stockpiles of food, grains, seeds and other items necessary to support food security. Savings can also come in the form of fungible assets, such as corrugated iron sheeting used on slum housing roofs (see box 9).[187]

Box 9. Risk financing strategies in urban slums

Research in four disaster-prone slum areas in El Salvador revealed that households spend an average 9.2 per cent – ranging from 0 to 75 per cent – of their yearly income on reducing disaster risk, and this cost figure does not include the time devoted to such activities. Strategies to reduce risk are very diverse. They may include building retention walls or embankments with old car tires, stones, bricks or nylon bags filled with soil and cement; clearing rivers of blocking objects; finding jobs outside the settlement that cannot be affected by local disasters; or creating information structures. Coping strategies not only include risk reduction, but also measures to finance emergency relief and recovery. For example, slum dwellers reported acquiring physical assets that can be easily sold if needed. One dweller deliberately fastened corrugated iron to his roof in an impermanent fashion so he could sell the iron in a post-disaster emergency. Further examples of financing mechanisms included saving money 'under the pillow', and community emergency funds. With respect to formal insurance, only 26 out of the 331 people included in the research had access to the Salvadoran social security system.

Source: Adapted from: Wamsler, C. 2007. Coping strategies in urban slums. State of the world 2007: our urban future. New York: The World Watch Institute, Norton & Company.

397. Increasingly, savings are becoming formalized through MFIs, banks and other agencies. Between 2004 and 2006 the value of global microsavings deposits increased by 24 per cent per year,[188] amounting to 1.3 billion 'accessible' savings accounts.[189] These institutions provide a certain measure of protection to ensure savings are accessible when needed, although during larger disasters smaller savings institutions can be affected themselves or have insufficient liquidity to handle a run on savings, as occurred during the 1998 floods in Bangladesh.[190] This offers an opportunity for the international adaptation community to provide security for these institutions.

[185] Carrasco and Ro, 2007.
[186] CGAP, 2005.
[187] Wamsler, 2007.
[188] MIX, 2008.
[189] See <http://www.cgap.org/>.
[190] Kull, 2006.

398. Savings as a financial mechanism can also be organized through less formal means, such as community-based organizations, which not only pool financial resources but often set up community grain and seed banks. Many microcredit programmes (reviewed in paras. 401–405 below) have attached or bundled compulsory savings programmes to collateralize loans, or bundled savings with disaster microinsurance, as with the Proshika scheme in Bangladesh (see box 10). Although normally not accessible until the end of the loan cycle, such forced savings can be made temporarily accessible to support clients during times of need.[191]

Box 10. Bundling savings with insurance in Bangladesh

Proshika, a large microfinance institution in Bangladesh, offers savings programmes with compulsory group-based disaster insurance to its clients. Under this programme, 2 per cent of the savings balance is annually transferred to a fund that will pay twice the amount of the savings deposit in the case of property damage due to disasters, while savings stay intact. The scheme operates without reinsurance or donor support. With more than two million clients in 20,000 villages and 2,000 slums, this insurance fund has wide geographical diversification. But the indemnity payments are only twice the amount in the savings account, which will probably be only a small percentage of disaster damage.

399. Despite the growth in the microsavings industry, most poor people still lack access to safe, formal deposit services.[192] In rural areas, savings institutions are often far away, or the time and procedures needed to open accounts make transactions too onerous or too expensive. Deposits are increasingly becoming a major funding source for microfinance institutions, further used as debt capital or leveraged in some other way by the institution.[193] This places deposits at risk. Furthermore, for many of the poor, who spend their limited income primarily on consumption and livelihood investments, opportunities to save are limited. A recent survey in rural northern India showed that less than 5 per cent of annual income was being saved, and that many farmers were in debt.[194]

400. Microsavings are a service of microfinance, which is dominated by microcredit. The potential for climate change adaptation funds to support microsavings will be considered in the next section on microcredit.

Microcredit

401. Epitomized by the Grameen Bank of Bangladesh, whose founder, Muhammad Yunus, was awarded the 2006 Nobel Peace Prize, microfinance has established itself as a mainstream financing mechanism in developing countries. Microfinance was started and continues to be driven by microcredit, the provision of small loans to the poor, although more complete financial services are increasingly being provided. At the end of 2006 the total number of microcredit clients was estimated at over 130 million, with at least 90 per cent of these considered among the poorest of society.[195] Considering that 3 billion people live on less than USD 2 per day, microcredit has significant growth potential.

402. Microcredit is used for a number of reasons, ranging from covering consumption needs during difficult times to financing business activities or investments. It is seen by some as an empowering tool that helps individuals manage and reduce their vulnerability and by others as an attempt to shift responsibility from social institutions to the poor. Although high compared with those found in industrialized countries, the 18–60 per cent interest rates charged on formal microcredit are far below the

[191] Kull, 2006.
[192] See <http://www.cgap.org/>.
[193] See <http://www.cgap.org/>.
[194] Hochrainer et al., 2009.
[195] Daley-Harris, 2007.

120–300 per cent often charged by the most common alternative source of credit, local moneylenders.[196] It is common for moneylenders to raise interest rates when demand is high, for instance after disasters.

403. In responding to dealing with climate-driven risks, microcredit can provide individuals and households with resources immediately after a disaster, but with an obligation to repay these resources at a later time – temporal risk spreading with full responsibility on the victim community. This is not without its own risks, however, as increased demand after a disaster can challenge the liquidity of microcredit organizations. The efficacy of providing post-disaster capital through credit as opposed to insurance is debated (see box 11).

Box 11. Is post-disaster microcredit an alternative to insurance?

There are divergent views on the value of emergency microcredit as an alternative to insurance for funding relief. Briceño (2005) sees post-disaster credit as an effective tool for reducing the impact of disasters: "In Bangladesh, for instance, those who were already benefiting from microfinance were more able to recover from the 1998 floods … through post-disaster loans." [a] Others view post-disaster credit as problematic. Jeanette Thompson (2005) cautions microfinance institutions against engaging in emergency microlending: "When clients lose property and productive assets, thus eroding their capacity to repay and absorb debt, a microfinance institution's portfolio quality and liquidity position are put at risk".[b] Another critic, Richard Leftley (2005), agrees: "It is certainly unwise to issue credit to people that have just experienced a significant disaster, as the infrastructure may be so damaged that their clients are unable or unwilling to purchase from them. The real benefit of MF [microfinance], however, is the provision of access to savings and insurance." [c]

[a] Briceno S. 2005. Foreword. United Nations International Strategy for Disaster Relief (ed.). *Invest to Prevent Disaster*. Geneva: United Nations International Strategy for Disaster Relief.
[b] Thompson J. 2005. A Microfinance Institution Perspective. *In* United Nations International Strategy for Disaster Relief (ed.). *Invest to prevent disaster*. Geneva: United Nations International Strategy for Disaster Relief.
[c] Leftley R. 2005. A Microfinance Institution Perspective. *In* United Nations International Strategy for Disaster Relief(ed.). *Invest to Prevent Disaster*. Geneva: United Nations International Strategy for Disaster Relief.

404. Microcredit can also support adaptation by reducing socioeconomic as well as physical vulnerability, for example through housing improvement loans linked to building code compliance.[197] Loans must, however, be designed appropriately for the intended purpose, since credit for consumption smoothing, business investment or asset building requires different amounts, terms and conditions.

405. An obstacle to the wider use of microfinance is that people living on low incomes cannot access financial products, such as bank accounts and low cost loans. This financial exclusion imposes real costs on individuals and their families since households that operate on a cash budget are unable to benefit from the savings available by paying by direct debits, are more vulnerable to financial loss or theft and are more likely to pay interest many times that of a standard personal loan. For this reason, development organizations and developing country governments are focusing on what are called 'financial inclusion' programmes to make a basic bank account available to low-income households.

[196] Grameen Foundation, 2008.
[197] Kull, 2006.

3. Collective loss sharing and solidarity

Post-disaster government assistance

406. Throughout much of the world, households, SMEs, farmers and other victims of climate-related disasters can anticipate support from their local and national governments through tax-payer solidarity to help them cope.

407. By acting as 'insurers of last resort', governments directly compensate victims for their losses. The level of compensation varies greatly between the developing and developed world, and even among highly vulnerable countries. In the United States, the average annual expenditure by the federal Government for disaster assistance greatly exceeds the average annual loss borne by reinsurers from United States catastrophe coverage.[198] Around a third of the USD 6.2 billion in direct losses from the 1993 Midwest floods in the country was reimbursed by federal and state government assistance. Similarly, the Government of Colombia spent USD 800 million to rebuild the cities of Armenia and Pereira after the 1999 earthquakes, including rebuilding private-sector properties. This was more than 50 per cent of the total direct damages.[199] The situation can be starkly different in the LDCs. After the devastating 1998 floods in Sudan, the Government provided compensation to victims worth only 15 per cent of the direct losses, and there was no private flood insurance or donor assistance to make up the deficit.[200]

408. Recognizing that government relief is likely to continue to play a role, it is important to consider how climate adaptation might be mainstreamed into relief expenditures, for example by requiring strict codes for any rebuilding or not providing aid to high-risk activities.

409. While opinions differ on the appropriateness of public risk financing mechanisms, it is widely agreed that the level of support that they can provide is limited in low- and middle-income countries, where governments often have insufficient funds after major disasters to repair critical infrastructure or provide assistance to the private sector. Post-disaster financing gaps are frequently encountered. This is discussed in chapter VI E.

International donor assistance

410. Solidarity extends beyond national borders and includes voluntary donations from the international community of individuals, NGOs and governments. Yet despite the comparatively large costs imposed by natural disasters on developing countries, reported figures suggest that direct donations from the developed world are small. One estimate of historical post-disaster donor assistance to developing countries averaged 10 per cent of the direct economic losses.[201] The amount depends greatly on the level of media attention given to the disaster and on geopolitical considerations.[202]

411. As with government post-disaster assistance, it is beneficial to design international assistance strategies that incorporate climate adaptation. This is already under way at the World Bank, and is an emerging topic at many bilateral development organizations.

D. Non-insurance risk-financing mechanisms at the meso scale

412. It is not only households, farms and SMEs that face climate-related risks that threaten their futures – the meso-scale agents that provide security to the micro-level agents also face risks. These

[198] Froot and O'Connell, 1999.
[199] Freeman et al.,2003.
[200] Linnerooth-Bayer and Mechler, 2007.
[201] Freeman et al., 2003.
[202] Mechler, 2003.

include marketing cooperatives, NGOs, donor organizations and MFIs. For example, MFIs, which provide credit after a disaster, may be unable to do so because they themselves face post-disaster capital deficits due to defaults on loans issued before the disaster.

413. To deal with this problem, a novel institution, the Emergency Liquidity Facility (ELF), was established. Based in Costa Rica, the fund provides immediate post-disaster liquidity at break-even rates to MFIs. The ELF was created with the participation of bilateral and multilateral organizations, as well as private investors. Low-interest credit enables MFIs to continue extending affordable credit in time of crisis, and the MFIs are encouraged to identify business opportunities and reliable entrepreneurs who can make effective post-disaster investments. There are currently 40 EFL-affiliated MFIs, indicating scope for expansion.

414. ELF is also a proactive fund, providing fledgling MFIs with advice and technical know-how to make their operations more resilient to disasters. To improve MFI performance, a risk assessment and contingency plan is produced, which includes measures in prevention (e.g. move computers out of harm's way), employee protection and organizational efficiency. There may be additional opportunities to require ELF-affiliated MFIs to issue priority loans that promote climate adaptation.

E. Non-insurance risk-financing mechanisms at the macro scale

415. In 1998, Hurricane Mitch caused the deaths of more than 11,000 people, destroying approximately 20 per cent of the public infrastructure in Honduras, and the homes and property of a large part of the population.[203] Honduras's GDP growth in the following year, despite the growth impetus from reconstruction, was 2 per cent lower than pre-disaster estimates.[204]

416. As this example illustrates, governments and other agents at the macro level can face huge challenges in meeting their post-disaster liabilities, which include, in addition to infrastructure repair and replacement, the provision of support to the most vulnerable. Public authorities have access to a variety of mechanisms for this purpose. They can raise funds by accessing international assistance, diverting funds from other budget items, imposing or raising taxes, taking a credit from the nation's central bank (which either prints money or depletes its foreign currency reserves), borrowing by issuing domestic bonds, borrowing from IFIs and issuing bonds on the international market.[205] With these mechanisms, with the exception of international assistance and low-interest loans offered by IFIs, the full burden of the disaster is borne by the citizens of the affected country. Typically, however, governments are ill prepared to meet these liabilities because disasters reduce tax revenue, increase fiscal deficits and worsen trade balances.[206] For this reason, emphasis has been placed on pre-disaster risk financing, such as creating a reserve fund or establishing contingent credit arrangements, as an addition or alternative to insurance instruments.

417. A survey of decision makers in Latin America and the Caribbean showed that 71–80 per cent of disaster-related resources are financed through post-disaster lending, budget transfers to the affected communities and post-disaster grants and aid.[207] Pre-disaster financing measures such as reserve funds or insurance were used to pay for only 20 per cent of disaster-related spending.

1. Budget diversions as a form of risk sharing at the governmental level

418. In the aftermath of a disaster, governments may divert funds from other budgeted projects to cover their post-disaster liabilities. In the developing countries, this often means diverting funds from international loans for infrastructure projects. Based on anecdotal evidence, Lester (1999) cites a figure

[203] Linnerooth-Bayer et al., 2001.
[204] Mechler, 2003.
[205] Benson, 1997; Fisher and Easterley, 1990.
[206] Otero and Marti, 1995.
[207] IDB, 2004.

of 30 per cent of infrastructure loans from the World Bank being diverted for this purpose. Although this response may be the least costly one for the government, it can be disruptive economically and politically. It depends on local budget appropriation and execution regulations, and most countries require that budget reallocations have parliamentary approval, which can delay appropriation of funding.

2. Intertemporal risk spreading at the governmental level

419. Beyond budget diversions, governments rely on an array of financial instruments that spread risk intertemporally (in contrast to non-life insurance pools, which spread risks spatially). These non-insurance (or quasi-insurance) instruments include reserve funds, post-disaster credit and contingent credit. Importantly, in contrast to budget diversions, and with the exception of post-disaster credit, these instruments are put into place before disasters happen, and thus allow a more stable and secure planning process.

Government reserve funds

420. To reduce their dependency on debt financing, some countries have instituted a catastrophe or calamity fund, which accumulates in years without catastrophes and is reduced or depleted in years with catastrophes, when the accumulated funds can be used to finance reconstruction and relief. For example, the Mexican catastrophe reserve fund, FONDEM, was set up to smooth the volatility of economic activity after natural disasters.[208] Costa Rica, Nicaragua and Honduras have also created national funds.[209] This financing option differs from a post-disaster tax, in that it does not have the disadvantage of high administrative costs – a catastrophe fund has a cost equal to the foregone return from maintaining liquid capital – and the resources can be made available immediately at lower transaction costs. A major problem with a fund, however, is that it may not be able to supply sufficient capital, especially if the disaster occurs shortly after its creation. In principle, insurance companies also operate with a reserve to cover large outlays; however, private insurers are more concerned than the government that their reserves are sufficient to avoid insolvency, and for this reason they diversify their insurance portfolio. A second problem with a catastrophe fund is the political risk that it could be diverted for other purposes in years when there were no disasters.

Post-disaster credit (debt instruments)

421. Issuing bonds and other debt instruments, which transfer the burden to future periods or even future generations, is the most common post-disaster financing mechanism, particularly for countries with a high credit standing or bond rating. The country can borrow either domestically or on the foreign market. Post-disaster credit can be less costly than insurance. Access to post-disaster credit is usually unproblematic for large economies where the impact of natural disaster does not significantly affect the economic growth and thus the ability of the country to service its debt. For example, the credit ratings of the United States and Japan were not affected by the occurrence of Hurricane Katrina in 2005 and the Kobe earthquake in 1995. By contrast, because their level of indebtedness is already high, small economies hit by disasters have restricted access to post-disaster credit. As pointed out by the World Bank (2006), the level of public debt in most island States is much higher than the average debt level of low-income countries and middle-income countries.

Pre-disaster contingency credit

422. Contingency credit is a financing mechanism whereby a government or other client pays a fee for the option of a guaranteed loan at a predetermined rate, contingent on a disaster or some other defined event occurring. The purpose is to provide immediate capital to the government when it is most needed. Although this form of financing can prove less expensive for a country than either a pure risk-transfer

[208] World Bank, 2000.
[209] Charveriat, 2000.

solution (such as insurance) or the accumulation of reserves, the major disadvantage is that the contingent debt can add to the country's debt burden. The appropriateness of this mechanism thus depends on the country's post-disaster financial profile, and more specifically on its post-disaster ability to service debt.

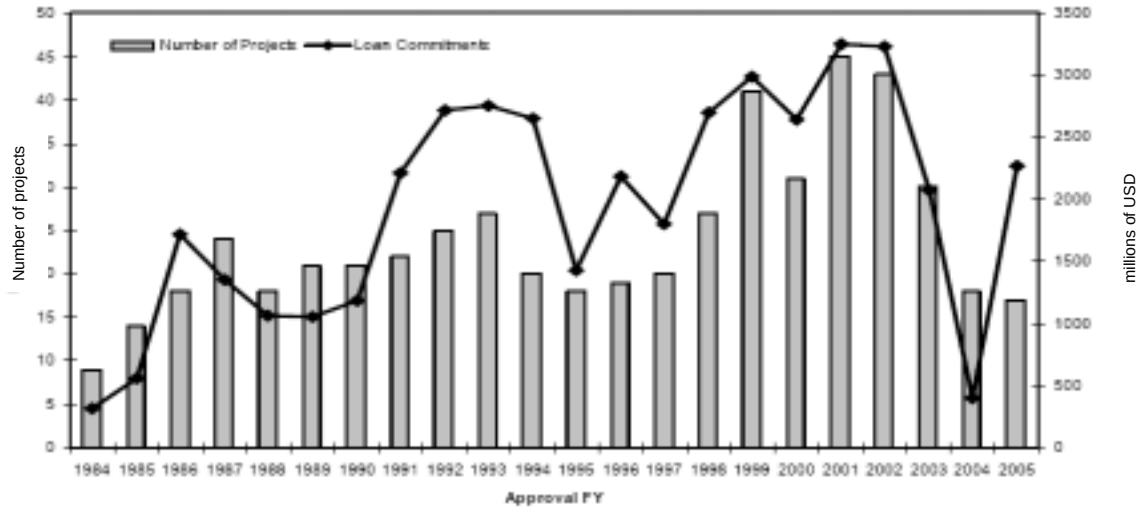
423. Colombia, which is highly prone to natural disasters, was the first country to secure contingent capital from the World Bank, in 2005.[210] The Government of Colombia and the World Bank designed a project that aims to strengthen national capacity to manage disaster risk, financed by a USD 260 million World Bank loan. This loan includes a USD 150 million contingent credit line that would provide the Government with immediate liquidity in the event of a major disaster occurring in Colombia. A similar instrument has been designed for the government of Mongolia.[211]

424. The World Bank is also offering a new financial product to middle-income country governments called the Catastrophe Risk Deferred Drawdown Option, or CAT DDO. Its purpose is to make financing immediately available after a natural disaster while other sources of funding, such as emergency relief aid, are being mobilized. Countries can access funds from the facility if they declare a state of emergency as a result of a natural disaster. Countries that sign up for the CAT DDO must have an adequate hazard risk management programme in place that is monitored by the World Bank.[212]

3. Collective loss sharing and solidarity at the international level

425. Governments facing a financing gap after a disaster often turn to international donors and international development banks. For low-income countries, bilateral donor assistance plays an important role, whereas for middle-income countries rely more on development lending from multilateral financial agencies. Since the early 1980s, the World Bank has initiated over 500 loans for disaster recovery and reconstruction purposes for a total disbursement of more than USD 40 billion,[213] (figure 22) and the Asian Development Bank also reports large loans for this purpose.[214]

Figure 22. World Bank emergency lending related to natural disasters



Source: World Bank. 2006. Hazards of Nature, Risks to Development: An Evaluation of the World Bank Assistance for the Natural Disasters. World Bank: Washington, DC.

[210] World Bank, 2005.
[211] World Bank, 2008a.
[212] World Bank, 2008b.
[213] World Bank, 2006.
[214] Arriens and Benson, 1999.

426. IFIs and donor organizations are greatly concerned about the dependence of developing countries on post-disaster capital grants and loans, and worried that international donations and loans for post-disaster reconstruction will account for an increasing portion of declining official development assistance.[215] They also claim that post-disaster assistance discourages governments from engaging in risk reduction activities, for which the returns can be substantial.[216] A major limitation of this ex post dependency is the growing discrepancy between the amount of reconstruction funds available from the international donor community and the growing funding needs of disaster-prone countries.

4. Sovereign risk transfer: catastrophe bonds, risk swaps and options

427. Because of the dependence of low-income governments on international grants and loans, the World Bank and other IFIs are encouraging them to proactively manage their risks and apply pre-disaster financing strategies. For several years there has been discussion in the insurance industry of the need for additional capital sources to participate in insuring the financial risk posed by natural catastrophes. As a variation on insurance, governments might follow the example of insurance companies and explore the potential of the capital markets to hedge exposure to catastrophe losses.

F. Comparing insurance and non-insurance mechanisms

1. Insurance cost and rationale

428. Throughout this document, advantages have been noted in using insurance mechanisms to reduce the effects of extreme weather events on national economies and provide security for investments as an important precondition to escape poverty. There are large potential benefits from insurance in the developing world: providing security against the wholesale loss of assets, livelihoods and even lives after disasters; changing the way development organizations provide disaster assistance and, at the same time, ensuring reliable and dignified post-disaster relief; setting powerful incentives for disaster risk prevention; and spurring economic development by freeing up resources for that purpose.

429. It should also be noted that the benefits come at a cost. Unlike the events covered by other types of insurance (e.g. life or health), catastrophes affect whole regions or countries at the same time (covariant risk), and the cost of providing this type of coverage is much greater. Premiums for catastrophe cover are inflated above the annual expected loss by an expense load, which reflects the costs of doing business, and a contingency load, which includes the cost of holding capital, the cost of assuming uncertain liabilities and frictional costs.[217] Frictional costs include costs resulting from information asymmetries between the capital markets and the insurer.

430. The contingency load distinguishes catastrophe insurance from other types of insurance. On account of the high-capital requirements for insuring covariant risks, the contingency load is far higher with catastrophe insurance than insurance for health, life and other non-covariant risks, and for this reason catastrophe insurance costs clients far more than their expected losses.

431. However, for more frequent events, such as those that concern individual farmers, for example, the contingency load is minor, and may be offset by the benefits of reduced variability that results from the pooling of risks.

432. In conventional loss-based insurance, distributed through specialist intermediaries, the expense load is high. The introduction of index-based microinsurance products has reduced the expense load, and made insurance viable for low-income segments in developing countries.[218,219,220]

[215] Mechler, 2003.
[216] Gurenko, 2004.
[217] World Bank, 2008a.
[218] Roth et al., 2007.
[219] USAID, 2006.

433. Although in aggregate insurance premiums cost clients more than the value of the losses, and sometimes significantly so, governments, households and other agents still see a rationale to insure.[221] The first reason for this is risk aversion. Risk-averse persons prefer lower consumption if it is steady to higher consumption if it is highly irregular or even subject to catastrophic shortfalls. This rationale for paying the price of insurance is highly relevant to poor households and farms, where a large loss (e.g. the loss of crops through drought) can threaten livelihoods and lives if victims cannot rely on informal risk-financing and self-insurance mechanisms. The second reason is almost contrary: hedging risk enables more entrepreneurial behaviour for wealth creation. Third, it is more efficient for people and entities to pool resources when dealing with uncertainty, rather than for each to stand by itself. The pooled insurance premiums can themselves be used as a driver of investment. Finally, by focusing on risk, loss prevention is given greater priority.

434. The important question then becomes whether other forms of risk sharing and spreading, as discussed throughout this chapter, can provide the security and other advantages offered by insurance. This question for macro and micro agents is considered in the following sections.

2. Comparing insurance and non-insurance mechanisms for financing liabilities

435. As shown in table 12, there are many dimensions of financing mechanisms that can be compared, including their political expediency and risks, the incentive structure, the environments they create for investment and development, and their equity. Insurance, in contrast to many non-insurance mechanisms, can provide strong incentives for risk-reducing adaptation measures, as well as provide security for investments that are needed for countries to escape poverty and build resilience to the impacts of climate change. In terms of equity considerations, all financial mechanisms can be constructed so that the costs are borne by the beneficiaries or by a wider social group.

436. An urgent issue facing finance ministries of developing countries is whether the government should insure its post-disaster liabilities or instead depend on a reserve fund, contingent credit and other conventional financial instruments. To explore this question, it is necessary to examine the respective costs of these instruments as well as their availability. Highly exposed developing countries often do not have sufficient access to post-disaster credit and other instruments shown in table 12, and international assistance may not make up the difference. These countries therefore face a potential financing gap, which suggests that they should consider purchasing insurance or other risk-transfer mechanisms before disaster strikes. In making such decisions, they should of course consider the immediate costs of the available options, and also the advantages, as outlined in table 12.

437. A similar argument applies for households, SMEs and other micro agents, which, according to a comparison of the relative costs of the options available, should turn to insurance only when the lower-cost alternatives are inadequate, or if there are compelling reasons to prefer insurance. Non-insurance instruments appear to work reasonably well for small localized events, but may not be sufficient for covariant or systemic shocks that affect entire risk-sharing communities.

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[220] Barrett et al., 2008.
[221] UNEPFI, 2007.

Table 12. Comparing insurance and non-insurance mechanisms for financing government liabilities

Mechanism	Examples	Advantages	Disadvantages
Non-insurance mechanisms			
Informal risk sharing	Diversions from other budgeted programmes	Can have low upfront cost	Potentially high social cost owing to fund diversion
Intertemporal risk spreading	Reserve fund	Fast access	May be insufficient, and ties up funds
	Post-disaster credit, contingency credit	Can be less expensive than insurance	May be difficult to access, especially for countries with large debts
Collective loss sharing (solidarity)	Bilateral and multilateral assistance	Low to zero cost, solidarity	Disincentives for prevention, ad hoc, provides no pre-disaster stability or security
Insurance mechanisms			
Risk pooling and transfer, insurance	Sovereign risk financing	Provides pre-disaster security and incentives for risk reduction. Promotes a conducive pre-event environment for investment	Variability load may make instruments costly
	Regional catastrophe insurance pools	Pooling reduces aggregate costs	More difficult to manage
Alternative risk transfer	Catastrophe bonds	Taps into global capital markets, bypasses middle agents	Can be costly to issue, basis risk
	Risk swaps, options and loss warranties	Access to further capital	Untested

G. Conclusions

438. This chapter has discussed an array of non-insurance mechanisms at the micro, meso and macro scale for coping with the impacts of climate change, especially climate variability and extremes, and for providing necessary capital to finance adaptation strategies. These mechanisms offer both advantages and disadvantages in comparison with insurance instruments. From a cost perspective, conventional financing mechanisms are generally a less expensive option than conventional insurance mechanisms to manage low-level risks, but the opposite is the case for infrequent events. The innovation of index-based microinsurance is proving an effective instrument for low-level covariant risks. The conclusion is that a portfolio of financial mechanisms is required to manage climatic risks.

439. One important distinction among non-insurance mechanisms is that market instruments place responsibility directly with the communities at risk, and solidarity instruments transfer this responsibility to national tax payers and the international community. Finding a middle way between responsibility and solidarity that presents opportunities for an international adaptation strategy to assist the most vulnerable in their struggle with climate impacts. The opportunity lies in the many possibilities for supporting market solutions so that they are accessible and affordable but still efficient. These possibilities include

'making markets work' (e.g. institution building, capacity-building and risk management) and 'making markets work for the very poor' (e.g. smart subsidies and capitalization of financial institutions).

440. Because of the incentives that they can provide towards anticipatory adaptation, market-based financial instruments can have significant advantages over conventional solidarity instruments. Moreover, formal market arrangements can provide the security necessary for loans that promote productive investments. Many donor organizations and IFIs are thus switching from post-disaster assistance to supporting pre-disaster financing arrangements.

441. Savings, credit and other market-based financial mechanisms are not available for a large majority of the most vulnerable communities at risk. An adaptation strategy could target resources on securing access. A few examples of possible measures at the micro and macro levels include:

(a) Providing technical support and capacity-building to create the institutions, risk assessments and other prerequisites for market-based risk management;

(b) Ensuring effective communication, for example by providing mobile phones to affected populations after a disaster, which would allow easier communication with foreign relatives and thus expedite remittances;

(c) Supporting financial inclusion policies that expand access to banking and other services;

(d) Supporting national governments in their efforts to raise pre-disaster financing, for example by providing expertise for securitizing national reserve funds;

(e) Using existing resources under the Convention and its Kyoto Protocol to facilitate access to these instruments.

442. Measures to provide access to market-based instruments do not address the core problem: no matter how accessible the market-based financial instruments are, the poorest of the poor cannot afford them and are likely to continue to rely on family, national or international solidarity to cope with climate impacts. Possible measures to make these instruments more affordable include:

(a) Financial support to microfinance institutions that serve the poorest of the poor;

(b) Capitalization of meso-scale institutions, such as emergency liquidity facilities, which could then offer lower rates of lending;

(c) Provision of support to LDC governments by capitalizing their reserve funds;

(d) Direct subsidies for financial instruments that minimize incentive distortions (known as "smart subsidies").

443. Opponents argue that subsidies can distort price signals and encourage maladaptation; and that capitalization can crowd out the private market. Yet most experts agree that even subsidized financial mechanisms are preferable to post-disaster aid, and the reinsurance market is not yet prepared to commit sufficient capital to markets serving the poor. Moreover, further product development is required to cater for national exposure to low-probability events. Experts also agree that international support should be closely coupled with a risk management programme. Good examples of this are the ELF, which requires providers of microfinance to submit a risk management plan before they are considered eligible for support, and the World Bank's Catastrophe Risk Deferred Drawdown Option, established in March 2008, which is available only to countries which have an adequate hazard risk management programme that is monitored by the World Bank.

VII. Final remarks

444. The Bali Action Plan has identified adaptation as one of the key building blocks for a strengthened future response to climate change in order to enable full, effective and sustained implementation of the Convention through long-term cooperative action now, up to and beyond 2012. The Bali Action Plan highlights the need for enhanced implementation of adaptation action including, inter alia, consideration of risk-management and risk-reduction strategies, including risk-sharing and transfer mechanisms such as insurance. The Bali Action Plan also highlights the need for enhanced support of adaptation through the provision of financial resources and investment.

445. Risk-transfer mechanisms, including both commercially provided and managed insurance and other forms of risk spreading and sharing (non-insurance) potentially have a major role to play in an expanded and strengthened adaptation response to the risks from climate change impacts.

446. The need for provision of risk-transfer mechanisms is widely accepted in recognition of the added burden that climate change impacts are imposing on sustainable development. Adaptive capacity of countries is being undermined by climate change impacts, and exposure of vulnerable countries and communities is increased. This means that LDCs, SIDS, countries in Africa and other vulnerable countries risk being caught in a downward spiral of increasing climate change risks and diminishing capacity to manage them.

447. As a result of the increased interdependence of countries on each other, unaddressed impacts in poor and vulnerable regions could cascade throughout the global society and economy. Hence, there is a need for involvement of the international community in supporting mechanisms that respond to the needs of vulnerable developing countries arising from the impacts of climate change.

448. Risks from climate change include long-term and inevitable risks, such as sea level rise, as well as risks where damage or ownership are difficult to quantify, such as the effect on ecosystems, livelihoods and cultural capital. These risks may ultimately constitute some of the most severe effects of climate change. Further risks are those that are short-term and acute, such as those due to extreme weather events, floods and drought. As the timing and scale of the hazards are not known, some of these risks may be transferred through financial markets. However, there are very few risk-transfer mechanisms currently available.

449. Indexed insurance instruments such as catastrophe bonds and weather derivatives may help developing countries, particularly rural communities, transfer some of the risks due to climate change and better cope with the impact of extreme events. Advantages include low moral hazard and adverse selection; no expensive loss adjustment for small units; less complex data requirements; less complex contracts; and rapid payout. The main disadvantage is ‘basis risk’ (the risk that the participants’ losses may not correlate with the index). At the state level, catastrophe bonds offer comparable opportunities to weather derivatives, but there has been less experience with them.

450. However, there are still practical hurdles to overcome with these products. Considerations for weather derivatives include low distribution in rural areas, the unfamiliarity of the public with insurance and the lack of weather data, as well as the lack of capacity to introduce such systems nationally because of the high level of technical and financial expertise required. The capacity to introduce such systems is lacking in LDCs, SIDS and many countries in Africa.

451. The development of microfinance, and now the innovation of microinsurance, for low-income segments, also offers great promise in tackling economic risks related to climate change. Initial experience indicates that products can be viable without subsidies once the initial costly research and development has been accomplished. Furthermore it is possible to link microinsurance to the financing of adaptive measures such as agricultural improvements so that resilience is enhanced. A useful typology

is to define the aim of a microinsurance scheme as a crisis, credit or continuity safety net, depending on the level of income of the target group.

452. Non-insurance mechanisms offer both advantages and disadvantages in comparison with insurance instruments. These mechanisms provide coping strategies at the micro, meso and macro scale, especially for coping with climate variability and extremes, and for providing necessary capital to finance adaptation strategies. From a cost perspective, conventional financing mechanisms are generally a less expensive option than conventional insurance mechanisms to manage low-level risks, but the opposite is the case for infrequent events. The innovation of index-based microinsurance is proving an effective instrument for low-level covariant risks.

453. Non-insurance mechanisms can:

(a) Provide direct financing for adaptation measures that reduce chronic climate impacts, such as using filters to respond to salt water intrusion, as well as measures for sudden-onset events, such as building levies;

(b) Serve communities that do not have insurance institutions in place or an insurance culture;

(c) In some contexts, offer a lower cost alternative to insurance for providing post-disaster capital;

(d) When so-called solidarity instruments are used, lighten the burden on the poor of climate impacts by redistributing responsibility.

454. Often, what is required for insurance schemes to be implemented in vulnerable countries is basic information, appropriate products and delivery channels. It is likely that after an initial phase of market development, insurance schemes can be self-sufficient once an appropriate framework has been established. The market development stage would need effective national adaptation plans that can help manage climate risks. The necessary capacity-building, technical training and feasibility studies, including demonstration or pilot insurance schemes, would benefit from external support.

455. It would be desirable to formulate estimates of global and regional costs of setting up insurance systems, as well the costs of supporting insurance schemes that may not be self-sustaining because the underlying risk is uninsurable. External support can also be used to catalyse the creation of new insurance schemes, thereby introducing the possibility of insurance to previously uninsurable situations and reducing insurance premiums that have been exacerbated by the additional burden of climate change.

456. In this regard, it would also be helpful to identify additional and predictable sources of funding that would secure the orderly operation of the various insurance-related actions and mechanisms that may benefit vulnerable communities. Several options for financing climate change risk management in developing countries are identified and described in this paper. A proposal made by the Alliance of Small Island States in 1991 is a precursor to many of the current proposals.

457. The schemes proposed in chapter V can be catalyzed by the international community. Scheme C has similarities with a risk management programme recently proposed by the Munich Climate Insurance Initiative, which is also described in this paper.

458. The schemes can benefit from strong external support to encourage their implementation and create the necessary conditions to develop the structures, coordinate local actors and engage the authorities. The aim of the schemes should be to create and develop local markets and through them provide market-based solutions for the sustainable growth of the participating nations. External support is helpful because there are not sufficient incentives for private actors to incur the overhead of market creation. However, once the market is created and developed, the aim should be to progressively phase

out external support for insurable risks. All the schemes are based on the assumption of global coordination, with political leadership.

459. Current and innovative financial and non-financial mechanisms and innovative insurance tools can be considered and can play a constructive role in a strengthened and expanded adaptation strategy or regime. Parties can consider appropriate mechanisms from the whole portfolio of options to respond to specific needs and circumstances arising from the adverse effects of climate change. The choice and mix of products is an important element in the design of any new and strengthened adaptation strategy or regime.

460. There are already insurance products for climatic hazards in developed countries and pilot schemes in developing countries. These could, in principle, provide valuable risk pooling services on a large scale for developing countries, particularly for climate hazards which are short-term and acute, and where there is a spatial and temporal uncertainty of impact, such as droughts and hurricanes.

461. Parties may use the suggestions on the insurance and non-insurance financial mechanisms discussed in this paper as they consider implementing adaptation action under the Convention, especially in the work of the AWG-LCA. This information can be used by Parties at the in-session workshop under the AWG-LCA on risk management and risk reduction strategies, including risk-sharing and risk-transfer mechanisms, to be held at COP 14 in Poznan, as well as in the negotiations of the Bali Action Plan on enhanced action on adaptation towards an agreement during COP 15 in Copenhagen.

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