

# **CLIMATE CHANGE:**

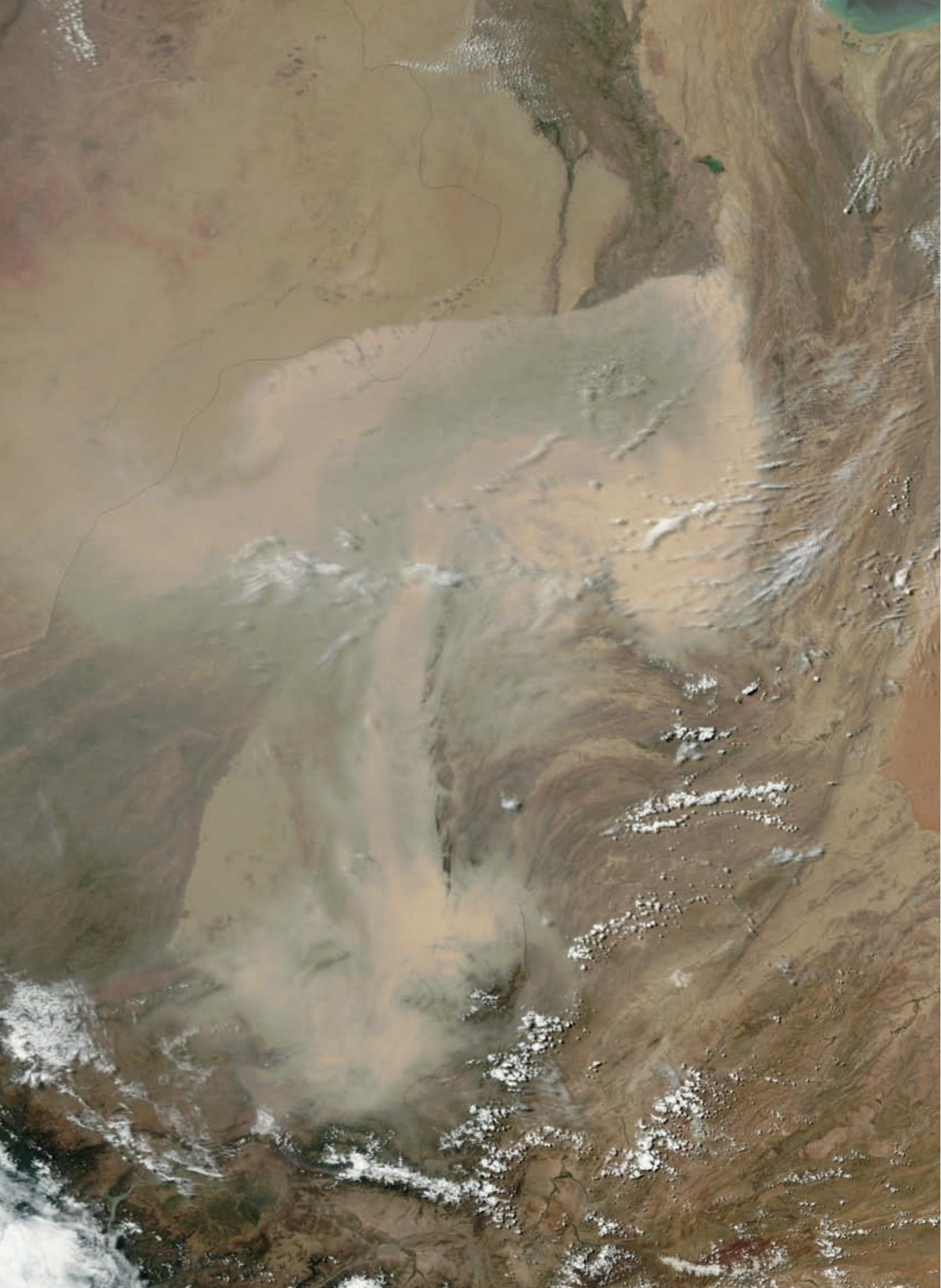
# **IMPACTS, VULNERABILITIES AND ADAPTATION IN DEVELOPING COUNTRIES**



UNFCCC

United Nations Framework Convention on Climate Change

# CLIMATE CHANGE: IMPACTS, VULNERABILITIES AND ADAPTATION IN DEVELOPING COUNTRIES



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# I. INTRODUCTION

The United Nations Framework Convention on Climate Change (UNFCCC) secretariat has produced this book to highlight the concerns and needs of developing countries in adapting to the effects of climate change. This book outlines the impact of climate change in four developing country regions: Africa, Asia, Latin America and small island developing States; the vulnerability of these regions to future climate change; current adaptation plans, strategies and actions; and future adaptation options and needs.

The book draws heavily on information provided by Parties to the UNFCCC, particularly that provided at three regional workshops held in Africa, Asia and Latin America and one expert meeting held in small island developing States during 2006–2007<sup>1</sup>, as mandated by the Buenos Aires programme of work on adaptation and response measures (decision 1/CP.10 of the Conference of the Parties to the UNFCCC)<sup>2</sup>, as well as information in national communications<sup>3</sup> and national adaptation programmes of action<sup>4</sup> submitted to the UNFCCC, reports from the Intergovernmental Panel on Climate Change (IPCC 2007) and other sources, as referenced.

Over the next decades, it is predicted that billions of people, particularly those in developing countries, face shortages of water and food and greater risks to health and life as a result of climate change. Concerted global action is needed to enable developing countries to adapt to the effects of climate change that are happening now and will worsen in the future.

The urgency for adaptation is highlighted by projections from the three reports produced by the IPCC in 2007 (IPCC 2007). Under a business as usual scenario, greenhouse gas emissions could rise by 25–90 per cent by 2030 relative to 2000 and the Earth could warm by 3°C this century. Even with a temperature rise of 1–2.5°C the IPCC predict serious effects including reduced crop yields in tropical areas leading to increased risk of hunger, spread of climate sensitive diseases such as malaria, and an increased risk of extinction of 20–30 per cent of all

plant and animal species. By 2020, up to 250 million people in Africa could be exposed to greater risk of water stress. Over the course of this century, millions of people living in the catchment areas of the Himalayas and Andes face increased risk of floods as glaciers retreat followed by drought and water scarcity as the once extensive glaciers on these mountain ranges disappear. Sea level rise will lead to inundation of coasts worldwide with some small island States possibly facing complete inundation and people living with the constant threat of tropical cyclones now face increased severity and possibly increased frequency of these events with all associated risks to life and livelihoods.

The UNFCCC secretariat, using current information available on existing and projected investment flows and financing relevant to the development of an effective and appropriate international response to climate change, has estimated that by 2030 developing countries will require USD 28–67 billion in funds to enable adaptation to climate change.<sup>5</sup> This corresponds to 0.2–0.8 per cent of global investment flows, or just 0.06–0.21 per cent of projected global GDP, in 2030. Current global funding for adaptation is a fraction of this figure and access to these funds for developing countries is often lengthy and complex.

Developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt: socially, technologically and financially. Climate change is anticipated to have far reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN 2007). Many developing countries' governments have given adaptation action a high, even urgent, priority.

<sup>1</sup> <<http://unfccc.int/3582.php>>  
<sup>2</sup> <<http://unfccc.int/resource/docs/cop10/10a01.pdf#page=2>>  
<sup>3</sup> <<http://unfccc.int/2979.php>>  
<sup>4</sup> <<http://unfccc.int/2719.php>>  
<sup>5</sup> <<http://unfccc.int/4053.php>>

Developing countries need international assistance to support adaptation in the context of national planning for sustainable development, more capacity-building and transfer of technology and funds. Systematic planning and capacity-building are also needed to reduce the risk of disasters and raise the resilience of communities to increasing extreme events such as droughts, floods and tropical cyclones. Funding for adaptation in developing countries must be sufficient and sustained. Least developed countries (LDCs) and small island developing States (SIDS) in particular need special consideration due to their extreme vulnerability.

In this book, background information on climate change and why adaptation is needed in developing countries is provided in [CHAPTER II](#). The chapter also explains how the UNFCCC, which provides the basis for international action on climate change, is helping adaptation efforts in developing countries.

A large amount of work has already been carried out by many countries on assessing impacts and vulnerabilities to climate change, as well as considering possible adaptation options. [CHAPTER III](#) covers how assessments on climate change are made by countries, including the gaps and needs of developing countries in information collection and analysis. Although there is still much work to be done, it was emphasised at all the UNFCCC-organized workshops and expert meeting that this should not be an obstacle to progress being made on implementing adaptation.

Developing countries have very different individual circumstances and the specific impacts of climate change on a country depend on the climate it experiences as well as its geographical, social, cultural, economic and political situations. As a result, countries require a diversity of adaptation measures very much depending on individual circumstances. However there are cross cutting issues which apply across countries and regions. The same sectors are affected by climate change, albeit to differing degrees. These main sectors include: agriculture, water resources, human health, terrestrial ecosystems and biodiversity and coastal zones. [CHAPTER IV](#) looks at the current and future impacts and vulnerabilities across these sectors in developing countries.

Although knowledge of how best to do adaptation is still in its infancy, the Parties of the UNFCCC are increasing their support for action on adaptation. This includes the development of national adaptation programmes by some developing countries including least developed countries, and their integration into national strategies. Climate change solutions need to identify and exploit synergy, as

well as seek to balance trade-offs, among the multiple objectives of sustainable development, disaster risk reduction and adaptation policies. Such initiatives also require new and sustained funding sources. [CHAPTER V](#) highlights the adaptation needs and responses of developing countries to climate change and how the work of the UNFCCC can help catalyse more work on adaptation in these countries. This chapter also highlights the need to plan and implement adaptation in the context of sustainable development and integrate adaptation into policy at all levels. Recommendations from the workshops and meeting on how to cross the gap between planning and implementing adaptation options are highlighted.

Finally, [CHAPTER VI](#) looks forward to give an indication of possible next steps for the UNFCCC, including within a future climate regime beyond 2012, in addressing adaptation options for the threats posed by climate change.



## II. CLIMATE CHANGE AND ADAPTATION

Rising fossil fuel burning and land use changes have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrogen dioxide (N<sub>2</sub>O), and a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally be radiated back into space. This increase in heat has led to the greenhouse effect, resulting in climate change. The main characteristics of climate change are increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity – due to seawater absorbing heat and carbon dioxide from the atmosphere (FIGURE II-1).

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) dispelled many uncertainties about climate change. Warming of the climate system is now unequivocal. It is now clear that global warming is mostly due to man-made emissions of greenhouse gases (mostly CO<sub>2</sub>). Over the last century, atmospheric concentrations of carbon dioxide increased from a pre-industrial value of 278 parts per million to 379 parts per million in 2005, and the average global temperature rose by 0.74° C. According to scientists, this is the largest and fastest warming trend that they have been able to discern in the history of the Earth. An increasing rate of warming has particularly taken place over the last 25 years, and 11 of the 12 warmest years on record have occurred in the past 12 years. The IPCC Report gives detailed projections for the 21st century and these show that global warming will continue and accelerate. The best estimates indicate that the Earth could warm by 3° C by 2100. Even if countries reduce their greenhouse gas emissions, the Earth will continue to warm. Predictions by 2100 range from a minimum of 1.8° C to as much as 4° C rise in global average temperatures.

Human beings have been adapting to the variable climate around them for centuries. Worldwide local climate variability can influence peoples' decisions with consequences for their social, economic, political and personal conditions, and effects on their lives and livelihoods. The effects of climate change imply that the local climate variability that people have previously experienced and have adapted to is changing and changing at relatively great speed.

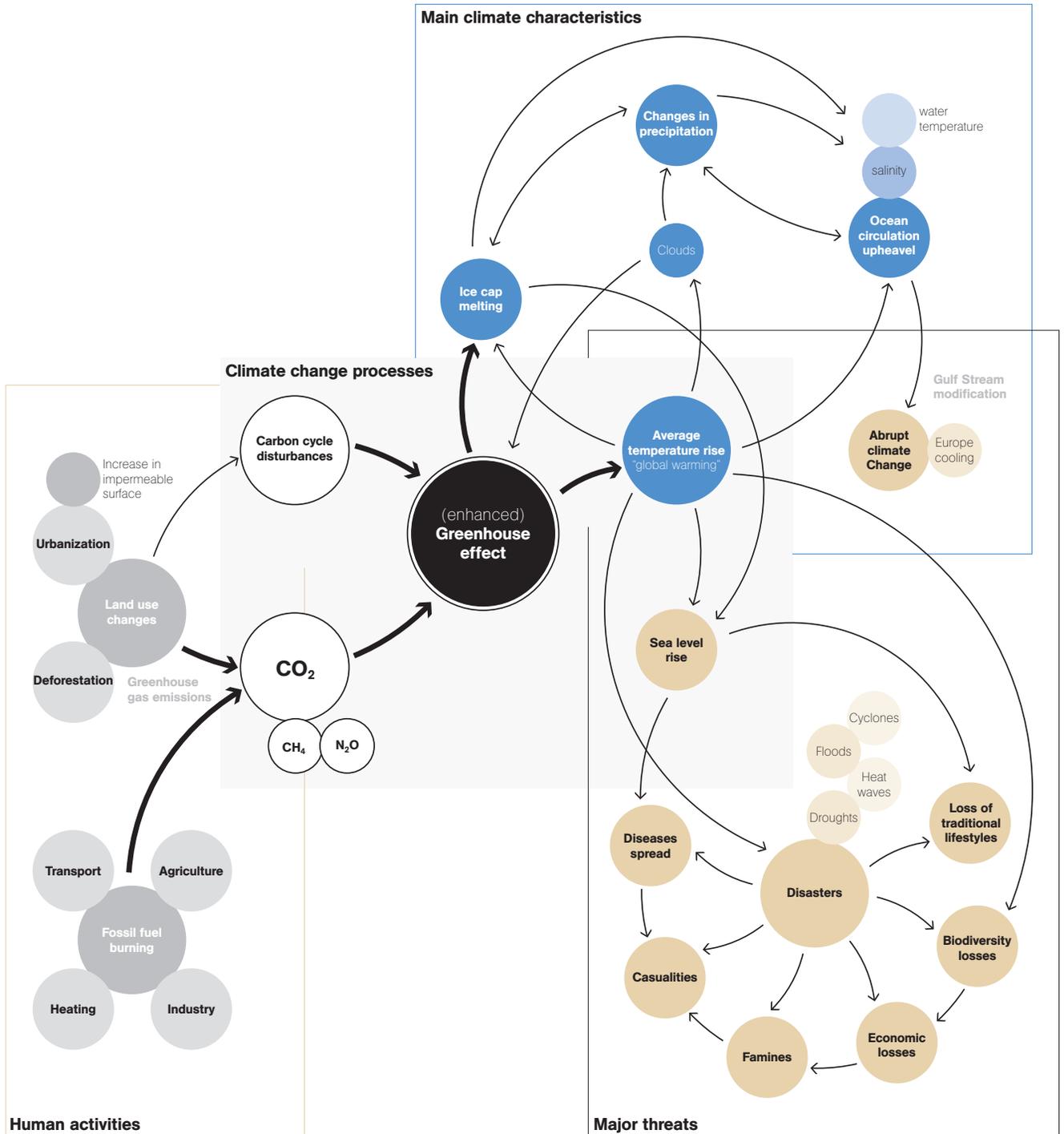
### 2.1 THE NEED FOR ADAPTATION

The major impacts and threats of global warming are widespread (FIGURE II-1). Increasing ocean temperatures cause thermal expansion of the oceans and in combination with meltwater from land-based ice this is causing sea level rise. Sea levels rose during the 20th century by 0.17 metres. By 2100, sea level is expected to rise between 0.18 and 0.59 metres. There are uncertainties in this estimate mostly due to uncertainty about how much water will be lost from ice sheets (Bindoff *et al.* 2007), for example Greenland is showing rising loss of mass in recent years (UNEP 2007). Increased melting of sea ice and freshwater influx from melting glaciers and ice sheets also has the potential to influence global patterns of ocean circulation.

As a result of global warming, the type, frequency and intensity of extreme events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases. Changes in some types of extreme events have already been observed, for example, increases in the frequency and intensity of heat waves and heavy precipitation events (Meehl *et al.* 2007).

Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria and dengue fever. Temperature increases will potentially severely increase rates of extinction for many habitats and species (up to 30 per cent with a 2° C rise in temperature). Particularly affected will be coral reefs, boreal

Figure II-1. Climate change: processes, characteristics and threats



Source: UNEP/GRID-Arendal, 'Climate change: processes, characteristics and threats', designed by Philippe Rekacewicz, UNEP/GRID-Arendal Maps and Graphics Library, 2005. <[http://maps.grida.no/go/graphic/climate\\_change\\_processes\\_characteristics\\_and\\_threats](http://maps.grida.no/go/graphic/climate_change_processes_characteristics_and_threats)> (Last accessed 10 October 2007)

forests, Mediterranean and mountain habitats. Increasing sea levels mean greater risk of storm surge, inundation and wave damage to coastlines, particularly in small island States and countries with low lying deltas. A rise in extreme events will have effects on health and lives as well as associated environmental and economic impacts.

Adaptation is a process through which societies make themselves better able to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These range from technological options such as increased sea defenses or flood-proof houses on stilts, to behaviour change at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water management, improved risk management, various insurance options and biodiversity conservation.

Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on climate change but also on the type of development path that is pursued. Thus adaptation should be implemented in the context of national and global sustainable development efforts. The international community is identifying resources, tools and approaches to support this effort.

## 2.2 ADAPTATION AND THE UNFCCC

At the centre of efforts to address climate change on the international stage is the United Nations Framework Convention on Climate Change (UNFCCC). “The UNFCCC provides the basis for concerted international action to mitigate climate change and to adapt to its impacts. Its provisions are far-sighted, innovative and firmly embedded in the concept of sustainable development” (UNFCCC 2006a). The UNFCCC entered into force on 21st March 1994 and there are now 191 Parties (member countries) to the Convention, an almost global membership.<sup>6</sup> These members are committed to: launch national strategies for adapting to expected impacts, including the provision of financial and technological support to developing countries, and to cooperate in preparing for adaptation to the impacts of climate change.

The Convention refers to adaptation in several of its articles (Box II-1), and the Conference of the Parties to the UNFCCC has made several decisions in regards to adaptation to climate change. The Convention’s Subsidiary Body for Implementation addresses agenda items on vulnerability and adaptation in the context of climate change negotiations. Particular attention has so far been given to issues relating to Article 4.8 and 4.9. Through the Subsidiary Body for Implementation, decisions have been made related to support and funding by Parties to assist developing countries with impact, vulnerability and adaptation assessment; capacity-building, training, education and public awareness; implementing concrete adaptation activities; promoting technology transfer; and exchanging experience through regional workshops. Attention has also been given to the scientific and technical aspects of adaptation and technology transfer, by the Convention’s Subsidiary Body for Scientific and Technological Advice. This includes the Nairobi work programme on impacts, vulnerability and adaptation to climate change (Nairobi work programme).<sup>7</sup> The Programme was adopted by the Conference of the Parties to the UNFCCC in 2005 and renamed in 2006 and its objective is twofold: to assist countries, in particular developing countries, including the least developed countries and small island developing States, to improve their understanding and assessment of impacts, vulnerability and adaptation; and to assist countries to make informed decisions on practical adaptation actions and measures to respond to climate change on a sound, scientific, technical and socio-economic basis, taking into account current and future climate change and variability.

By its decision 1/CP.10, paragraph 8, the Conference of the Parties requested the UNFCCC secretariat to organize three regional workshops for Africa, Asia and Latin America and one expert meeting for small island developing States (SIDS).<sup>8</sup> These workshops and meetings were mandated in order to enable Parties and other experts from these four regions to reflect on their regional priorities; to facilitate information exchange and integrated assessments within and between regions; and to help identify specific adaptation needs and concerns.

Part of the mandate from the Conference of the Parties was for the UNFCCC secretariat to prepare reports, including a synthesis report, on the outcome of these workshops in order for the Subsidiary Body for Implementation to consider what further actions may be required on the international stage to promote adaptation in developing countries.

**Box II-1. Convention articles referring to adaptation**

All Parties are to "formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to ... facilitate adequate adaptation to climate change". Article 4.1(b)

All Parties shall "Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods". Article 4.1(e)

All Parties shall "Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change". Article 4.1(f)

"The developed country Parties ... shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects". Article 4.4

"The Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures". Article 4.8

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

The UNFCCC secretariat produced background papers for each of the workshops: Africa (UNFCCC 2006c), Asia (UNFCCC 2007b), Latin America (UNFCCC 2006b) and the SIDS expert meeting (UNFCCC 2007a). Following the workshops and meetings, summary reports were produced: Africa (UNFCCC 2007c), Asia (UNFCCC2007e), Latin America (UNFCCC 2006d) and SIDS (UNFCCC 2007d). The synthesis report of these workshops and meeting summarizes the identified adaptation needs and concerns, particularly those for which there was common interest across the regions (UNFCCC 2007f). The report includes recommendations by the Chair of the Subsidiary Body for Implementation on possible next steps by Parties. This publication draws upon the proceedings and outcomes of these workshops and meeting. The work of the regional workshops, mandated by the Subsidiary Body for Implementation, is complemented by ongoing work on the Nairobi work programme organized under the Subsidiary Body for Scientific and Technological Advice.

<sup>6</sup> <<http://unfccc.int/2631.php>>

<sup>7</sup> <<http://unfccc.int/3633.php>>

<sup>8</sup> Decision 1.CP/10, see <<http://unfccc.int/resource/docs/cop10/10a01.pdf#page=2>>



### III. ASSESSING THE IMPACTS OF, AND VULNERABILITY AND ADAPTATION TO, CLIMATE CHANGE

Assessing the impacts of and vulnerability to climate change and subsequently working out adaptation needs requires good quality information. This information includes climate data, such as temperature, rainfall and the frequency of extreme events, and non-climatic data, such as the current situation on the ground for different sectors including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones (see CHAPTER IV).

This chapter describes what information is collected to assess climate variability and change, and the tools used for assessing the impacts and vulnerability of developing countries to climate change. If the capacity for assessing climate change is not there, countries are limited in their ability to plan adaptation measures and adapt effectively.

#### 3.1 INFORMATION GATHERING – DATA, SYSTEMATIC OBSERVATION AND MONITORING

For countries to understand their local climate better and thus be able to predict local climate change, they must have adequate operational national systematic observing networks, and access to the data available from other global and regional networks. Systematic observations of the climate system are usually carried out by national meteorological centres and other specialised centres. They take observations at standard preset times and places, and monitor atmosphere, ocean and terrestrial systems. The major climate variables measured include temperature, rainfall, sea surface temperature, sea level rise, wind speeds, tropical cyclones (including hurricanes and typhoons), snow and ice cover.

A sure knowledge base from systematic observation and forecasting services is essential to monitor climate; detect and attribute climatic change; improve the understanding of the dynamics of the climate system and its natural variability; provide input for climate models; and thus plan adaptation options. For example, monitoring trends of sea surface temperature and sea level are essential in order

to assess their impacts on the increased intensity of tropical cyclones and storm surge; monitoring events relating to the phenomenon of El Niño Southern Oscillation (ENSO) is important in helping determining its effects on reducing or increasing precipitation in different regions leading to both floods and drought.

Article 5 of the UNFCCC refers to the need for the international community to support and further develop climate research and systematic observation systems, taking into account the concerns and needs of developing countries. As part of this recognition, the COP invited the Global Climate Observing System (GCOS)<sup>9</sup> to launch a regional workshop programme in 2000 to identify the priority capacity-building needs and identify gaps in regional systematic observation (see FCCC/SBSTA/2006/MISC.13, UNFCCC 2006f). Action Plans were subsequently developed and are now being implemented for developing country regions including Eastern and Southern Africa, Western and Central Africa, East and Southeast Asia, Central Asia, South and Southwest Asia, South America, Central America and the Caribbean, and the Pacific Islands. The plans highlight the need for a better knowledge base, better forecasting and climate services and a need to improve observations at all levels to enhance countries' ability to adapt. They emphasise that effective adaptation planning requires improved observations; improved regional, national and global data, as well as denser networks; the recovery of historical data; building of support among the user communities that have a demand for climate information; and promoting greater collaboration between the providers and users of climate information.

At all the UNFCCC workshops and meeting, participants reported that observations and data availability still need to be improved in all regions. At the Africa workshop, participants agreed that systematic observation networks in Africa are inadequate because there is a lack of stations and lack of maintenance. Participants reiterated that missing and scattered observational climate data in Africa is a constraint to understanding current and future climate variability. If data exist, there are difficulties in obtaining it. Participants underlined the importance of implementing the GCOS Action Plan for Africa, the "Climate Information for Development Needs: An Action Plan for Africa", to improve the situation. Launched in 2007, the plan aims to improve the inadequate and deteriorating observing systems through an integrated programme that includes not only observations, but also climate services and climate risk management and policy.

<sup>9</sup> <<http://www.wmo.ch/pages/prog/gcos/index.php>>

In most countries of Asia, the meteorological or hydro-meteorological department of the government is responsible for collecting, processing and supplying data as well as maintaining infrastructure of the systematic observation system. Participants at the Asia workshop highlighted the need to improve observations and data availability, including in islands, mountainous, and coastal ecosystems, at the national, regional and global levels. Efforts regarding the harmonization and consistency of data should be enhanced through improved coordination between data providers from different sectors. For example, China reported at the workshop on the improvements it is making to its systematic observation network under the framework of the China GCOS programme. China is monitoring atmospheric composition, energy balance, water and carbon cycles, ecosystems, land use, ice and snow, and regularly submits real-time observation data of China GCOS stations and historical data records from national stations to the World Data Center for Meteorology. The country has an operational system of short-term climatic monitoring, prediction and assessment, established in the Beijing Climate Centre, and has some regional cooperative climate programmes with other Asian developing countries such as the Islamic Republic of Iran, Nepal, Sri Lanka and Uzbekistan.

In Latin America, workshop participants reported that climate information is either unavailable or sparse, and it is difficult to use it for modelling and scenario development. According to the GCOS February 2005 report, another reason for large gaps in observational coverage lies in the fact that the network of national correspondents works only on a voluntary basis. Retirements, political instability, economic problems and over-tasking of staff are a few of the issues that endanger the continuity of climate data series (GCOS 2005). The workshop reported a significant gap in observational coverage and that the problem is more acute for some regions, mainly the higher elevations along the Andean Mountain Range. This range constitutes a major determinant of the climate systems of the continent and high-elevation data is important for the detection and assessment of climate change and its impacts on glaciers, snow cover, and run-off. It was reported that the websites of national meteorological services, in general, do not make datasets available to allow studies of detection and attribution of climate change and there are just a few countries in Latin America which, at present, have active climate change programs. It was emphasised as urgent to implement plans for investments in meteorological information and to improve Latin American countries' capabilities and knowledge to undertake and maintain systematic, long-term, climate observational programs, along with the capacity to undertake analyses of climatic information.

In small island developing States the national meteorological and hydrological services are the responsible agency for climate observations. However, it was reported at the expert meeting that many networks are not working efficiently due to: limited assigned satellite windows for data transmission; low frequency of recordings; delays in maintenance and replacement and incorrect calibration of equipment; and limited access to products and services. Following 10 GCOS regional workshops between 2000 – 2006, elements of the regional action plans are now being implemented. The Pacific Islands Global Climate Observing System is addressing capacity-building needs, improving observing stations, climate prediction, telecommunication and data rescue. The Regional Action Plan for Central America and the Caribbean is partly being implemented through the Mainstreaming Adaptation to Climate Change project. This includes upgrades of observation networks, data rescue, and assessment of surface and groundwater monitoring networks.

In summary, the UNFCCC-organized workshops and meeting in 2006 – 2007 highlighted that there is still a need to take stock of available climate information in developing countries so that it is clear where the systematic observation needs are most pressing. Follow-up actions include improving and sustaining operational observing networks, such as the GCOS observational networks. Collaboration between national and international providers of climate information and the users, in all sectors, of such information for adaptation to climate change is vital as well as generating awareness among different user communities of the usefulness of climate information and services and improving national and regional coordination. Data needs to be carefully packaged so that it can be used effectively. Rescuing historical meteorological data is important. Education and training and improved national planning and reporting would also help build capacity.

At the workshops and meeting, it was highlighted that it is not just climate data that is needed for effective vulnerability and adaptation assessments to climate change in developing countries. Equally as important, and very much lacking at present, is the need for accurate socio-economic data. This data needs to come from across sectors and is an important complement to existing assessments, particularly given that poverty has been recognized as a major factor in vulnerability.

### 3.2 INFORMATION ANALYSIS – REPORTING OF IMPACTS, VULNERABILITY AND ADAPTATION

Reliable, systematic climate data helps countries determine their current climate variabilities, and model future changes. Countries use a number of assessment models, tools and methodologies as well as various scenarios, including those provided by the IPCC (IPCC 2000), to help provide an assessment of the future impacts of climate change. Climate change impacts, vulnerability and adaptation assessments need to generate outputs that are policy relevant. To do this, climate change data including future impacts and vulnerabilities needs to be integrated with socioeconomic data and analyses across a range of sectors, and the results must be tailored for policymakers and stakeholders.

All Parties to the UNFCCC are committed to submit national communications in which they outline the implementation of the UNFCCC and the impacts from climate change that they are facing. In their national communications, countries provide an assessment of vulnerabilities and adaptation options. Water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones are common sectors for which impacts and vulnerability assessment have been carried out by developing countries.

At the workshops and expert meeting, vulnerability and adaptation assessments were identified as vital tools for developing countries to evaluate and implement responses to climate change. A major problem in all regions was the limited capacity at regional and national level due to deficiencies in data collection and the lack of technical expertise. It was highlighted as important to make the models, tools and methodologies that are appropriate for assessments in developing countries more widely available. Exchanging information on tools used for vulnerability and adaptation assessments, together with the outcomes of these assessments, would help countries improve capacity in this area. This could be done through workshops and symposia, regional science journals, websites to facilitate information exchange and by making better use of existing channels of information.

The resolution of models used to determine climate change in developing countries is too coarse and often relies on data from sources in other countries. Along with the disparity in outputs from different models, this makes the use of results as a basis for adaptation action very difficult. A major problem encountered when using models to get national results is the need for readjustment and downscaling to suit a country's individual needs. Participants highlighted the need for enabling training on

the use of models and tools in all regions and providing technical support, such as through the training of trainers on modelling tools, and follow-up through regional centres of excellence, to address gaps in expertise in the application of methods and tools and in using climate information and geographical information systems. At the SIDS meeting special mechanisms for vulnerability and adaptation assessment training, including short courses and longer-term professional training incorporating capacity-building for participatory approaches, were mentioned as a follow-up action.

The development of higher resolution regional models for developing countries is important as well as analysing the disparity between the model outcomes. This would help enhance capacity for reaching informed decision making. For example, at the Africa workshop, participants emphasised the need to develop regional climate models to provide fine-scale climate information for long-term impact studies and forecasting, as well as facilitate information exchange between African institutions. Some efforts are being undertaken in this regard in developing countries, and regional models are being developed that are capable of providing more useful information needed by planners and policy makers. For example, the Hadley Centre's model PRECIS (Providing REgional Climates for Impacts Studies)<sup>10</sup> has been designed for use by local meteorological offices or research institutes. Training on this model has been undertaken in several developing countries, including Cuba, Brazil, Argentina, South Africa and India, and Jamaica, Cuba and Barbados mentioned at the expert meeting that results from the model have been used in vulnerability assessments.

At the SIDS meeting it was further highlighted that establishing a group of experts to facilitate assessments for specific circumstances of SIDS would be useful. Establishing a roster of experts with specialized skills, in all regions at centres of excellence, would help to maintain experts working in the regions. This would also help continuity in impact and vulnerability assessment, a problem highlighted at the Africa meeting where participants emphasized that the impact and vulnerability assessment undertaken in the initial national communication process was disjointed from that of the second national communication.

Participants at all workshops and at the expert meeting emphasised the lack of socio-economic data, or indeed development indicators and relevant tools for enhancing

<sup>10</sup> <<http://precis.metoffice.com>>

the use of socio-economic assessment in a way that would be relevant to policy makers and other stakeholders, including ministries of finance and economy. It is important to link climate vulnerability to socio-economic studies and long-term periodic and socio-economic assessments. Preserving indigenous knowledge that is relevant to community level responses, studies on coping strategies, and gender specific vulnerability assessments were all highlighted as important elements to determining adaptation options.

Useful methodologies for assessing adaptation options include both top-down and bottom-up approaches. Both methodologies need to be linked to promote integrated adaptation assessments. Top-down methodologies include the use of modelling and scenario analysis. This can provide useful background to decision making and is strong in terms of the biophysical aspects of impacts. However the models do not perform well in representing human interactions and local abilities to adapt. This is highlighted by an example from the Cook Islands (Box III- 2).

As a complement to the top-down approach is a vulnerability-based, bottom-up, approach, which recognizes and builds upon local coping strategies and indigenous knowledge and technologies, and the capacity and coping range of communities, local institutions and sectors in

responding to current climate variability. This approach helps to incorporate human and economic dimensions of the local communities, particularly livelihood aspects and inter-sectoral relationships. It is useful in developing specific strategies and policy implementation. However, it exhibits a weaker attribution to future climate change.

An example of this approach is the UNFCCC's National Adaptation Programmes of Action (NAPAs) for use by least developed countries to prioritize their urgent adaptation needs.<sup>12</sup> The rationale for NAPAs rests on the limited ability of least developed countries to assess their vulnerability and adapt to climate change. A new approach was needed that would focus on enhancing adaptive capacity to climate variability and thus help these countries directly address their urgent needs arising from the adverse effects of climate change. The NAPAs use and build upon existing coping strategies at the grassroots level, rather than focusing on scenario-based modelling, to assess future vulnerability and adaptive responses at local and state level. Involvement of different stakeholders (national, sectoral, local) and including existing coping strategies are an integral part in the assessment process.

<sup>11</sup> Adapted from a presentation given by Ms. Pasha Carruthers on this topic at the UNFCCC CGE Regional Hands-on Training Workshop on Vulnerability and Adaptation Assessments for the Asia and the Pacific Region, held in Jakarta, Indonesia on 20 to 24 March 2006.

<sup>12</sup> <<http://unfccc.int/2719.php>>

**Box III-2. Experience of the Cook Islands in applying impacts assessments methodologies<sup>11</sup>**

As part of the Pacific Island Climate Change Assistance Programme which aims to help Pacific islands meet their reporting obligations to the UNFCCC, the Cook Islands applied the prototype integrated assessment model PACCLIM (PACific CLimate Impacts Model). This model was developed by the International Global Change Institute in New Zealand and involved the integration of a global climate model with climate data and a regional climate scenario generator. Economic activity in the Cook Islands includes tourism, pearls, commercial and subsistence fisheries and coastal floodplain agriculture. The Cook Islands faced numerous challenges when

carrying out the assessment, including gaining trust for the project, the limited time to carry out the project, the presentation of complex material, gathering the relevant input, recording feedback, verifying anecdotal evidence and quantifying observations and uncertainties. The conclusion was that the tool had limited applicability for the Cook Islands and was rather complicated, and that it would be better to focus on refining data collection and on improving results by using simpler methods. The tool could be better used for training in identifying cross-sectoral considerations.



## IV. REGIONAL IMPACTS OF AND VULNERABILITIES TO CLIMATE CHANGE

This chapter highlights the impacts of and the vulnerabilities to climate change in the four regions: Africa, Asia, Latin America and small island developing States. Impacts and vulnerabilities vary by region and were reported in the background papers to the workshops and meeting held in these regions by the UNFCCC (UNFCCC 2006b, 2006c, 2007a, 2007b) and in presentations during the workshops and meeting themselves.<sup>13</sup> Additional sources, including information for the IPCC Fourth Assessment Report (IPCC 2007), are used here to complement the information provided at the workshops and meeting and are referenced where used.

### 4.1 AFRICA

Africa is already a continent under pressure from climate stresses and is highly vulnerable to the impacts of climate change. Many areas in Africa are recognized as having climates that are among the most variable in the world on seasonal and decadal time scales. Floods and droughts can occur in the same area within months of each other. These events can lead to famine and widespread disruption of socio-economic well-being. For example, estimates reported at the workshop indicate that one third of African people already live in drought-prone areas and 220 million are exposed to drought each year.

Many factors contribute and compound the impacts of current climate variability in Africa and will have negative effects on the continent's ability to cope with climate change. These include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. The overexploitation of land resources including forests, increases in population, desertification and land degradation pose additional threats (UNDP 2006). In the Sahara and Sahel, dust and sand storms have negative impacts on agriculture, infrastructure and health.<sup>14</sup>

TABLE IV-1 highlights some impacts of climate change in Africa on key sectors and gives an indication of the adaptive capacity of this continent to climate change. As a result of global warming, the climate in Africa is predicted to become more variable, and extreme weather events are expected to be more frequent and severe, with increasing risk to health and life. This includes increasing risk of drought and flooding in new areas (Few *et al.* 2004, Christensen *et al.* 2007) and inundation due to sea-level rise in the continent's coastal areas (Nicholls 2004; McMichael *et al.* 2006).

Africa will face increasing water scarcity and stress with a subsequent potential increase of water conflicts as almost all of the 50 river basins in Africa are transboundary (Ashton 2002, De Wit and Jacek 2006). Agricultural production relies mainly on rainfall for irrigation and will be severely compromised in many African countries, particularly for subsistence farmers and in sub-Saharan Africa. Under climate change much agricultural land will be lost, with shorter growing seasons and lower yields. National communications report that climate change will cause a general decline in most of the subsistence crops, e.g. sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; Millet in Sudan; and groundnuts in Gambia. Of the total additional people at risk of hunger due to climate change, although already a large proportion, Africa may well account for the majority by the 2080s (Fischer *et al.* 2002).

Africa is vulnerable to a number of climate sensitive diseases including malaria, tuberculosis and diarrhoea (Guernier *et al.* 2004). Under climate change, rising temperatures are changing the geographical distribution of disease vectors which are migrating to new areas and higher altitudes, for example, migration of the malaria mosquito to higher altitudes will expose large numbers of previously unexposed people to infection in the densely populated east African highlands (Boko *et al.* 2007). Future climate variability will also interact with other stresses and vulnerabilities such as HIV/AIDS (which is already reducing life expectancy in many African countries) and conflict and war (Harrus and Baneth 2005), resulting in increased susceptibility and risk to infectious diseases (e.g. cholera and diarrhoea) and malnutrition for adults and children (WHO 2004).

Climate change is an added stress to already threatened habitats, ecosystems and species in Africa, and is likely to trigger species migration and lead to habitat reduction. Up to 50 per cent of Africa's total biodiversity is at risk due to reduced habitat and other human-induced pressures (Boko *et al.* 2007). The latter include land-use conversion due to agricultural expansion and subsequent destruction

Table IV-1. Regional Impacts and Vulnerabilities to Climate Change in Africa

Impacts	Sectoral vulnerabilities	Adaptive Capacity
<p><b>Temperature</b></p> <ul style="list-style-type: none"> <li>– Higher warming (x1.5) throughout the continent and in all seasons compared with global average.</li> <li>– Drier subtropical regions may become warmer than the moister tropics.</li> </ul> <p><b>Precipitation</b></p> <ul style="list-style-type: none"> <li>– Decrease in annual rainfall in much of Mediterranean Africa and the northern Sahara, with a greater likelihood of decreasing rainfall as the Mediterranean coast is approached.</li> <li>– Decrease in rainfall in southern Africa in much of the winter rainfall region and western margins.</li> <li>– Increase in annual mean rainfall in East Africa.</li> <li>– Increase in rainfall in the dry Sahel may be counteracted through evaporation.</li> </ul> <p><b>Extreme Events</b></p> <ul style="list-style-type: none"> <li>– Increase in frequency and intensity of extreme events, including droughts and floods, as well as events occurring in new areas.</li> </ul>	<p><b>Water</b></p> <ul style="list-style-type: none"> <li>– Increasing water stress for many countries.</li> <li>– 75–220 million people face more severe water shortages by 2020.</li> </ul> <p><b>Agriculture and food security</b></p> <ul style="list-style-type: none"> <li>– Agricultural production severely compromised due to loss of land, shorter growing seasons, more uncertainty about what and when to plant.</li> <li>– Worsening of food insecurity and increase in the number of people at risk from hunger.</li> <li>– Yields from rain-fed crops could be halved by 2020 in some countries. Net revenues from crops could fall by 90% by 2100.</li> <li>– Already compromised fish stocks depleted further by rising water temperatures.</li> </ul> <p><b>Health</b></p> <ul style="list-style-type: none"> <li>– Alteration of spatial and temporal transmission of disease vectors, including malaria, dengue fever, meningitis, cholera, etc.</li> </ul> <p><b>Terrestrial Ecosystems</b></p> <ul style="list-style-type: none"> <li>– Drying and desertification in many areas particularly the Sahel and Southern Africa.</li> <li>– Deforestation and forest fires.</li> <li>– Degradation of grasslands.</li> <li>– 25–40% of animal species in national parks in sub-Saharan Africa expected to become endangered.</li> </ul> <p><b>Coastal Zones</b></p> <ul style="list-style-type: none"> <li>– Threat of inundation along coasts in eastern Africa and coastal deltas, such as the Nile delta and in many major cities due to sea level rise, coastal erosion and extreme events.</li> <li>– Degradation of marine ecosystems including coral reefs off the East African coast.</li> <li>– Cost of adaptation to sea level rise could amount to at least 5–10% GDP.</li> </ul>	<p>Africa has a low adaptive capacity to both climate variability and climate change exacerbated by existing developmental challenges including:</p> <ul style="list-style-type: none"> <li>– low GDP per capita</li> <li>– widespread, endemic poverty</li> <li>– weak institutions</li> <li>– low levels of education</li> <li>– low levels of primary health care</li> <li>– little consideration of women and gender balance in policy planning</li> <li>– limited access to capital, including markets, infrastructure and technology</li> <li>– ecosystems degradation</li> <li>– complex disasters</li> <li>– conflicts</li> </ul>

Source: Boko et al. (2007), Christensen et al. (2007).

<sup>13</sup> <<http://unfccc.int/3582.php>>

<sup>14</sup> Presentation from Ms. Balgis Osman Elasha, UNFCCC African Regional Workshop on Adaptation, Accra, Ghana, 21 to 23 September 2006. <<http://unfccc.int/3743.php>>

of habitat; pollution; poaching; civil war; high rates of land use change; population growth and the introduction of exotic species. For example, the habitat of the great apes, including the western lowland Gorilla – identified as critically endangered on the World Conservation Union's (IUCN) red list of threatened species, is likely to seriously decline between 2002 and 2032.<sup>15</sup>

Future sea level rise has the potential to cause huge impacts on the African coastlines including the already degraded coral reefs on the Eastern coast. National communications indicate that the coastal infrastructure in 30 percent of Africa's coastal countries, including the Gulf of Guinea, Senegal, Gambia, Egypt, and along the East-Southern African coast, is at risk of partial or complete inundation due to accelerated sea level rise.<sup>16</sup> In Tanzania, a sea level rise of 50 cm would inundate over 2,000 km<sup>2</sup> of land, costing around USD 51 million (UNEP 2002a). Future sea level rise also threatens lagoons and mangrove forests of both eastern and western Africa, and is likely to impact urban centres and ports, such as Cape Town, Maputo, and Dar Es-Salaam.

## 4.2 ASIA

Asia is the largest continent on Earth and spreads over four climatic zones (boreal, arid and semi-arid, tropical and temperate). The region faces formidable environmental and socio-economic challenges in its effort to protect valuable natural resources. Land and ecosystems are being degraded, threatening to undermine food security. In addition, water and air quality are deteriorating while continued increases in consumption and associated waste have contributed to the exponential growth in the region's existing environmental problems. Furthermore, the region is highly subject to natural hazards, such as the 2004 Indian Ocean Tsunami, the 2005 Pakistan Earthquake, and the 2006 landslides in the Philippines. There is evidence of prominent increases in the intensity and/or frequency of many extreme weather events such as heat waves, tropical cyclones, prolonged dry spells, intense rainfall, tornadoes, snow avalanches, thunderstorms, and severe dust storms in the region (Cruz *et al.* 2007). Impacts of such disasters range from hunger and susceptibility to disease, to loss of income and livelihoods, affecting human survival and well-being. For example the extreme weather events in China during 2006 included major storms and flooding in the east and south, as well as heat and drought in central, western and northeastern regions, killing more than 2700 people and causing USD 20 billion in damages.

Climate change will affect many sectors, including water resources, agriculture and food security, ecosystems and biodiversity, human health and coastal zones (TABLE IV-2). Many environmental and developmental problems in Asia will be exacerbated by climate change.

Under climate change, predicted rainfall increases over most of Asia, particularly during the summer monsoon, could increase flood-prone areas in East Asia, South Asia and Southeast Asia. In Central and South Asia, crop yields are predicted to fall by up to 30 per cent, creating a very high risk of hunger in several countries.

Global warming is causing the melting of glaciers in the Himalayas. In the short term, this means increased risk of flooding, erosion, mudslides and GLOF in Nepal, Bangladesh, Pakistan, and north India during the wet season. Because the melting of snow coincides with the summer monsoon season, any intensification of the monsoon and/or increase in melting is likely to contribute to flood disasters in Himalayan catchments. In the longer term, global warming could lead to a rise in the snowline and disappearance of many glaciers causing serious impacts on the populations relying on the 7 main rivers in Asia fed by melt water from the Himalayas. Throughout Asia one billion people could face water shortage leading to drought and land degradation by the 2050s (Christensen *et al.* 2007, Cruz *et al.* 2007).

In Asia, the principal impacts of climate change on health will be on epidemics of malaria, dengue, and other vector-borne diseases (Martens *et al.* 1999). The global burden of climate change-attributable diarrhoea and malnutrition are already the largest in the world in Southeast Asian countries including Bangladesh, Bhutan, India, Maldives, Myanmar and Nepal in 2000. Illness and death are expected to increase from diarrhoeal diseases due to drought and flooding, and are also expected from increased amounts of cholera bacteria in coastal waters. An increase in the frequency and duration of severe heat waves and humid conditions during the summer is likely to increase the risk of mortality and morbidity, principally in the old and urban poor populations of temperate and tropical Asia (Epstein *et al.* 1995) and high temperatures and poor urban air quality, such as in Chongqing, China and in Jakarta, Indonesia, could contribute to widespread heat stress and smog induced illnesses in urban populations (Cruz *et al.* 2007).

Table IV-2. Regional Impacts and Vulnerabilities to Climate Change in Asia

Impacts	Sectoral vulnerabilities	Adaptive Capacity
<p><b>Temperature</b></p> <ul style="list-style-type: none"> <li>– Warming above the global mean in central Asia, the Tibetan Plateau, northern, eastern and southern Asia. Warming similar to the global mean in Southeast Asia.</li> <li>– Fewer very cold days in East Asia and South Asia.</li> </ul> <p><b>Precipitation, snow and ice</b></p> <ul style="list-style-type: none"> <li>– Increase in precipitation in most of Asia. Decrease in precipitation in central Asia in Summer.</li> <li>– Increase in the frequency of intense precipitation events in parts of South Asia, and in East Asia.</li> <li>– Increasing reduction in snow and ice in Himalayan and Tibetan Plateau glaciers</li> </ul> <p><b>Extreme Events</b></p> <p>Increasing frequency and intensity of extreme events particularly:</p> <ul style="list-style-type: none"> <li>– droughts during the summer months and El Niño events;</li> <li>– increase in extreme rainfall and winds associated with tropical cyclones in East Asia, Southeast Asia and South Asia;</li> <li>– intense rainfall events causing landslides and severe floods;</li> <li>– heat waves/hot spells in summer of longer duration, more intense and more frequent, particularly in East Asia.</li> </ul>	<p><b>Water</b></p> <ul style="list-style-type: none"> <li>– Increasing water stress to over a hundred million people due to decrease of freshwater availability in Central, South, East and Southeast Asia, particularly in large river basins such as Changjiang.</li> <li>– Increase in the number and severity of glacial melt-related floods, slope destabilization followed by decrease in river flows as glaciers disappear.</li> </ul> <p><b>Agriculture and food security</b></p> <ul style="list-style-type: none"> <li>– Decreases in crop yield for many parts of Asia putting many millions of people at risk from hunger.</li> <li>– Reduced soil moisture and evapotranspiration may increase land degradation and desertification.</li> <li>– Agriculture may expand in productivity in northern areas.</li> </ul> <p><b>Health</b></p> <ul style="list-style-type: none"> <li>– Heat stress and changing patterns in the occurrence of disease vectors affecting health.</li> <li>– Increases in endemic morbidity and mortality due to diarrhoeal disease in south and Southeast Asia.</li> <li>– Increase in the abundance and/or toxicity of cholera in south Asia.</li> </ul> <p><b>Terrestrial Ecosystems</b></p> <ul style="list-style-type: none"> <li>– Increased risk of extinction for many species due to the synergistic effects of climate change and habitat fragmentation.</li> <li>– Northward shift in the extent of boreal forest in north Asia, although likely increase in frequency and extent of forest fires could limit forest expansion.</li> </ul> <p><b>Coastal Zones</b></p> <ul style="list-style-type: none"> <li>– Tens of millions of people in low-lying coastal areas of south and Southeast Asia affected by sea level rise and an increase in the intensity of tropical cyclones.</li> <li>– Coastal inundation is likely to seriously affect the aquaculture industry and infrastructure particularly in heavily-populated megadeltas.</li> <li>– Stability of wetlands, mangroves, and coral reefs increasingly threatened.</li> </ul>	<p>Adaptive capacity varies between countries depending on social structure, culture, economic capacity, geography and level of environmental degradation.</p> <p>Capacity is increasing in some parts of Asia, for example the success of early warning systems for extreme weather events in Bangladesh and the Philippines. However, capacity is still constrained due to poor resource bases, inequalities in income, weak institutions and limited technology.</p>

Source: Christensen et al. (2007), Cruz et al. (2007).

<sup>15</sup> <[http://maps.grida.no/go/graphic/loss\\_of\\_great\\_ape\\_habitat\\_2002\\_2032\\_africa](http://maps.grida.no/go/graphic/loss_of_great_ape_habitat_2002_2032_africa)>  
<sup>16</sup> <[http://unfccc.int/national\\_reports/non-annex\\_i\\_natcom/items/2979.php](http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php)>

In recent years, enormous pressures have been put on Asia's ecosystems to support the ever growing demand for natural resources. The most affected areas are coastal and marine ecosystems, forests and mountainous regions and the flora and fauna within them. Climate change will have a profound effect on the future distribution, productivity, and health of forests throughout Asia, for example northeast China may become deprived of conifer forest.<sup>17</sup> Grassland productivity is expected to decline by as much as 40–90 per cent for an increase in temperature of 2–3° C, combined with reduced precipitation, in the semi-arid and arid regions of Asia.

Fisheries in both fresh water and sea water could be affected. Fisheries at higher elevations are likely to be adversely affected by lower availability of oxygen due to a rise in surface air temperatures. In the plains, the timing and amount of precipitation could also affect the migration of fish species from the river to the floodplains for spawning, dispersal, and growth (FAO 2003). Sea level rise and changes in sea water temperature, salinity, wind speed and direction, strength of upwelling, mixing layer thickness and predator response to climate change have the potential to substantially alter fish breeding habitats and food supply for fish and ultimately the abundance of fish populations in Asian waters with associated effects on coastal economies (Cruz *et al.* 2007).

Projected sea level rise could flood the residence of millions of people living in the low lying areas of South, Southeast and East Asia such as in Viet Nam, Bangladesh, India and China (Wassmann *et al.* 2004, Stern 2006, Cruz *et al.* 2007) and 30 percent of coral reefs could be lost in the next 10 years (Cruz *et al.* 2007). The loss may be as high as 88 per cent (59 per cent of global) in the next 30 years (Sheppard 2003; Wilkinson 2004).

### 4.3 LATIN AMERICA

Latin America includes much of the world's biological diversity, as well as a wide variety of ecosystems, climatic regions, topographies and land-use patterns. Particularly vulnerable to climate change are the water, agriculture and health sectors, the Andean glaciers, the Amazon region and regions vulnerable to extreme climatic events (UNFCCC 2006d). The impacts of climate change in this region and its adaptation potential are highlighted in [TABLE IV-3](#). The region has already been experiencing climate-related changes with the frequency and intensity of extreme events, particularly those associated with the ENSO phenomenon. Torrential rains and resulting floods, including those associated with tropical cyclones, have result in tens of

thousand of deaths and severe economic losses and social disruption in the region in recent years<sup>18</sup>, for example in 1998 hurricane Mitch caused 10,000 deaths and severe damage to infrastructure, with Honduras and Nicaragua the worst hit. Northeast Brazil, on the other hand, is particularly affected by drought and its associated socio-economic impacts (Charvériat 2000).

Under climate change, as Andean glaciers disappear this century, there is likely to be serious effects on peoples lives and livelihoods and on ecosystems. Currently people in Bolivia, Chile, Ecuador and Peru, along the Andean Cordillera, depend on glacial seasonal discharge for their water supply as well as for hydro-energy. Higher rates of economic recession correspond with greater flows of water, which cause erosion, flooding and mudslides in lowland areas. However, as the glaciers disappear – such as the Chacaltaya Glacier in Bolivia, predicted to disappear within the next 15 years – flows will tail off dramatically leading to serious water shortages, reduced hydropower, greater risks of drought, as well as flooding, and serious environmental degradation (nef 2006, Magrin *et al.* 2007, UNEP 2007).

There are uncertainties over the effects of climate change on rainfall in Latin America. However it is predicted that arid and semi-arid areas will receive even less rain under climate change leading to degradation of agricultural land and impacting food security. Except for mid-latitude areas, where CO<sub>2</sub> fertilization effects may balance out the negative effects of climate change, agricultural yields are expected to decrease throughout Latin America by the end of the Century.

As well as through extreme events, the main risks of climate change on health and life are from heat stress – particularly due to urban heat island effects in megacities, and transmissible diseases including malaria, dengue and cholera (Githeko and Woodward, 2003, Patz 2005). Rodent-borne infections can also increase after floods and droughts such as leptospirosis and Hantavirus Pulmonary Syndrome (Ahern *et al.* 2005). Expected increases in forest fires due to warmer, drier climate and increased deforestation and forest fragmentation are likely to heighten the vulnerability of the population to the health impacts of biomass burning smoke, the effects of which have already been observed in Brazil (Haines and Patz 2004; Patz 2004).

Table IV-3. Regional Impacts and Vulnerabilities to Climate Change in Latin America

Impacts	Sectoral vulnerabilities	Adaptive Capacity
<p><b>Temperature</b></p> <ul style="list-style-type: none"> <li>– Warming above the global mean is predicted in most of Latin America.</li> <li>– In southern South America warming similar to global mean.</li> </ul> <p><b>Precipitation, snow and ice</b></p> <ul style="list-style-type: none"> <li>– Decrease in annual precipitation in most of Central America and in the southern Andes, although large local variability in mountainous areas.</li> <li>– Increase in winter precipitation in Tierra del Fuego.</li> <li>– Increase in summer precipitation in south-eastern South America.</li> <li>– Uncertain rainfall changes over northern South America, including the Amazon forest.</li> <li>– Increasing reduction and disappearance of Andean glaciers.</li> </ul> <p><b>Extreme events</b></p> <p>Increasing frequency and intensity of extreme events, many related to ENSO, particularly:</p> <ul style="list-style-type: none"> <li>– intense rainfall events causing landslides and severe floods;</li> <li>– dry spells and drought, such as in northeast Brazil;</li> <li>– heat waves, with particularly major effects in megacities due to heat island effects;</li> <li>– Increase in intensity of tropical cyclones in the Caribbean basin.</li> </ul>	<p><b>Water</b></p> <ul style="list-style-type: none"> <li>– Increase in the number of people experiencing water stress – likely to be 7–77 million by the 2020s.</li> <li>– Runoff and water supply in many areas compromised due to loss and retreat of glaciers.</li> <li>– Reduction in water quality in some areas due to an increase in floods and droughts.</li> </ul> <p><b>Agriculture and food security</b></p> <ul style="list-style-type: none"> <li>– Reductions of crop yields in some areas, although other areas may see increases in yields.</li> <li>– By the 2050s, 50% of agricultural lands are very likely to be subjected to desertification and salinization in some areas.</li> <li>– Food security a problem in dry areas where agricultural land subject to salinization and erosion reducing crop yields and livestock productivity.</li> </ul> <p><b>Health</b></p> <ul style="list-style-type: none"> <li>– Risks to life due to increases in the intensity of tropical cyclones.</li> <li>– Heat stress and changing patterns in the occurrence of disease vectors risk to health.</li> </ul> <p><b>Terrestrial Ecosystems</b></p> <ul style="list-style-type: none"> <li>– Significant habitat loss and species extinctions in many areas of tropical Latin America, including tropical forests, due to higher temperatures and loss of groundwater with effects on indigenous communities.</li> </ul> <p><b>Coastal Zones</b></p> <ul style="list-style-type: none"> <li>– Impacts on low lying areas, such as the La Plata estuary, coastal cities and coastal morphology, coral reefs and mangroves, location of fish stocks, availability of drinking water and tourism due to sea level rise and extreme events.</li> </ul>	<p>The lack of modern observation equipment and climate monitoring hinders the quality of forecasts lowering public trust in climate records and applied meteorological services. This has a negative impact on the quality of the early warning and alert advisory services.</p> <p>Some social indicators have improved in recent decades including life expectancy, adult literacy and freshwater access. However, adaptive capacity is limited by high infant mortality, low secondary school enrolment and high levels of inequality both in income and in access to fresh water and health care as well as gender inequalities.</p>

Source: Christensen *et al.* (2007), Magrin *et al.* (2007).

<sup>17</sup> Presentation by Mr. Mozaharul Alam, UNFCCC Asian Regional Workshop on Adaptation, 11-13 April, Beijing, China. <<http://unfccc.int/3955.php>>

<sup>18</sup> Presentation from Mr. Carlos Nobre, UNFCCC Latin American regional workshop on adaptation, Lima, Peru, 18 to 20 April 2006. <<http://unfccc.int/3719.php>>

The Amazon Basin is home to some 40 per cent of the world's remaining tropical forest and contains one of the Earth's richest assortments of biodiversity; thousands of species of plants, over a million insect species, more than 700 fish species, 1,000 bird species, and over 300 mammalian species. The reduction of tropical forest area, especially in the tropical rainforests, will probably entail the loss of many species (Scholze *et al.* 2005). Climate change threatens to substantially affect the Amazon region, which in turn is expected to alter global climate and increase the risk of biodiversity loss (WWF 2006). By 2050 for a projected increase of 2° C surface temperature, severe species loss is predicted over central Brazil, Mexico and in dry areas of Argentina, Bolivia and Chile (Thomas *et al.* 2004; Siqueira and Peterson 2003; Miles *et al.* 2004). The central-eastern Amazon is predicted to undergo an irreversible process of 'savannization' (Nobre *et al.* 2004).

Low-lying coasts in several countries (Argentina, Belize, Colombia, Costa Rica, Ecuador, Guyana, Mexico, Panama, El Salvador, Uruguay, Venezuela) and large cities (Buenos Aires, Rio de Janeiro, Recife, etc.) are among the most vulnerable to extreme weather events such as rain, windstorms and hurricanes with their associated storm surges and sea level rise.

National communications report that sea level rise is likely to have adverse impacts on: buildings and tourism, (e.g. in Mexico, Uruguay); coastal morphology (e.g. in Peru); mangroves (e.g. in Brazil, Ecuador, Colombia, Venezuela); and availability of drinking water in the Pacific coast of Costa Rica, Ecuador and the River Plate estuary. Mesoamerican coral reefs (e.g. Mexico, Belize, Panama); and the location of fish stocks in the south-east Pacific (e.g. Peru, Chile) are also likely to be affected.

Mangrove forests located in low-lying coastal areas are particularly vulnerable to sea level rise, increased mean temperatures, and hurricane frequency and intensity, especially in Mexico, Central America and Caribbean continental regions (Magrin *et al.* 2007) and could disappear unless they are better managed (Medina *et al.* 2001, McLeod and Salm 2006). Fish stocks are also affected by warmer sea waters with resulting negative consequences for fishing in the region.

Salinization of drinking water could become an increasingly serious problem in coastal areas due to sea level rise. Sea-level rise in some areas may lead to a reduction in the salinity of hypersaline lagoons negatively affecting biodiversity (Quammen and Onuf 1993).

#### 4.4 SMALL ISLAND DEVELOPING STATES

The small island developing States comprise 51 States and Territories spread over the Pacific, Indian and Atlantic Oceans and Caribbean Sea, and are highly vulnerable to the effects of climate change and already feeling its impacts. The climate of SIDS is influenced by large ocean-atmosphere interactions such as trade winds, El Niño and the monsoons. Small island developing States are characterised by the concentration of large settlements with associated economic and social activities at or near the coast. In SIDS, arable land, water resources and biodiversity are already under pressure from sea level rise. Increases in population and the unsustainable use of available natural resources add further problems. Tropical storms and cyclones cause storm surges, coral bleaching, inundation of land, and coastal and soil erosion with resulting high-cost damages to socio-economic and cultural infrastructure. For example, in the Pacific islands region, cyclones accounted for 76 per cent of the reported disasters between 1950 and 2004, with the average costs relating to damage caused per cyclone standing at USD 75.7 million in 2004 value (World Bank 2006a). In the Caribbean region, the 2004 hurricane season alone caused damages estimated at USD 2.2 billion in four countries: the Bahamas, Grenada, Jamaica and the Dominican Republic.<sup>19</sup>

The projected impacts of climate change cross all sectors and the vulnerability and low adaptive capacity of SIDS is inextricably linked to the socio-cultural and economic context of these island States (TABLE IV-4). Vulnerabilities include low availability of resources, a small but rapidly growing population, remoteness, susceptibility to natural disasters, excessive dependence on international trade, and vulnerability to global developments.

Water supply in SIDS is likely to be exacerbated by future climate change. Freshwater lenses are predicted to reduce in size due to increased demand and reduced rainfall. It has been estimated that a 10 per cent reduction in average rainfall by 2050 could produce a 20 per cent reduction in the size of the freshwater lens on the Tarawa Atoll, Kiribati, and reduce the thickness of the freshwater lens on atolls by as much as 29 percent. Freshwater supplies are also threatened by saltwater intrusion due to storm surge and sea level rise (Mimura *et al.* 2007).

The projected impacts of climate change on agriculture include extended periods of drought, loss of soil fertility and shortening of the growing season which will lead to major economic losses and seriously affect food security.

Table IV-4. Regional Impacts and Vulnerabilities to Climate Change in small island developing States

Impacts	Sectoral vulnerabilities	Adaptive Capacity
<p><b>Temperature</b></p> <ul style="list-style-type: none"> <li>– All Caribbean, Indian Ocean and North and South Pacific small island States will experience warming. Warming will be lower than the global average.</li> </ul> <p><b>Precipitation</b></p> <ul style="list-style-type: none"> <li>– Decrease in summer rainfall in the Caribbean in the vicinity of the Greater Antilles.</li> <li>– Increase in annual rainfall in the equatorial Pacific and in the northern Indian Ocean, in the Seychelles and the Maldives.</li> <li>– Decrease in rainfall in the vicinity of Mauritius, in the Indian Ocean, and east of French Polynesia, in the Pacific.</li> </ul> <p><b>Extreme Events</b></p> <ul style="list-style-type: none"> <li>– Increasing intensity of tropical cyclones, storm surge, coral bleaching and land inundation.</li> </ul>	<p><b>Water</b></p> <ul style="list-style-type: none"> <li>– Water sources seriously compromised due to rising sea level, changes in rainfall and increased evapotranspiration, e.g. in the Pacific, a ten percent reduction in average rainfall (by 2050) would lead to a twenty percent reduction in the size of the freshwater lens on the Tarawa Atoll, Kiribati.</li> </ul> <p><b>Agriculture and food security</b></p> <ul style="list-style-type: none"> <li>– Agricultural land and thus food security affected by sea-level rise, inundation, soil salinization, seawater intrusion into freshwater lenses, and decline in freshwater supply.</li> <li>– All agricultural production affected by extreme events.</li> <li>– Fisheries affected by increasing sea surface temperature, rising sea level and damage from tropical cyclones.</li> </ul> <p><b>Health</b></p> <ul style="list-style-type: none"> <li>– Increases in the intensity of tropical cyclones increase risks to life.</li> <li>– Heat stress and changing patterns in the occurrence of disease vectors and climate sensitive diseases affect health.</li> </ul> <p><b>Terrestrial Ecosystems</b></p> <ul style="list-style-type: none"> <li>– Replacement of local species and colonization by non-indigenous species.</li> <li>– Forests affected by extreme events are slow to regenerate. Forest cover may increase on some high latitude islands.</li> </ul> <p><b>Coastal Zones</b></p> <ul style="list-style-type: none"> <li>– Most infrastructure, settlements and facilities located on or near the shore and will be affected by sea-level rise, coastal erosion and other coastal hazards, compromising the socio-economic well-being of island communities and states.</li> <li>– Accelerated beach erosion, degradation of coral reefs and bleaching will all have impacts on incomes from fishing and tourism.</li> <li>– Habitability and thus sovereignty of some states threatened due to reduction in island size or complete inundation.</li> </ul>	<p>Small islands, whether located in the tropics or higher latitudes are especially vulnerable to the effects of climate change, sea level rise and extreme events.</p> <p>Characteristics such as limited size, proneness to natural hazards and external shocks enhance the vulnerability of islands to climate change. In most cases they have low adaptive capacity, and adaptation costs are high relative to GDP.</p>

Source: Christensen *et al.* (2007), Mimura *et al.* (2007).

<sup>19</sup> United Nations Economic Commission for Latin America and the Caribbean press release. <<http://www.reliefweb.int/rw/rwb.nsf/db9005ID/JCDR-677LG57?OpenDocument>>

On many islands, prime agricultural land is located on the coastal plains which are already threatened by sea-level rise. The relative magnitude of economic losses due to climate change is likely to differ among islands. For example, in the absence of adaptive measures on a high island such as Viti Levu in Fiji, the cost of damages could be in the range of USD 23–52 million per year (2–3 per cent of GDP) by 2050 whereas in a low island such as Tarawa, Kiribati, the annual average cost of damages would be in the order of USD 8–16 million (17–18 per cent of GDP) by 2050 (World Bank 2000).

In SIDS, increasing extreme events such as tropical cyclones are predicted to have huge impacts on forest cover and biodiversity, particularly as adaptation responses on small islands are expected to be slow, and impacts of storms may be cumulative (Mimura *et al.* 2007). Changes in temperature are likely to particularly affect high elevation SIDS, and biological invasions are predicted to drive several species, including many endemic birds, to extinction (Wormworth and Mallon 2006).

Increasing temperatures and decreasing water availability due to climate change may also increase the burden of diarrhoeal and other infectious diseases in some small island States. Increases in tropical cyclones, storm surges, flooding, and drought are likely to have both short- and long-term effects on human health, including drowning, injuries, increased disease transmission, decreases in agricultural productivity and subsequent malnutrition.

Coastlines will almost certainly suffer from accelerated coastal erosion as well as inundation of settlements and arable land with associated social and economic consequences. For example, in Grenada, a 50 cm rise in sea level could lead to serious inundation with 60 per cent of beaches in some areas being lost (UNFCCC 2007a). A one-metre rise in sea level is expected to cost Jamaica USD 462 million, 19 per cent of its GDP (Jamaica 2000); while for the Maldives a one-meter rise in sea level would mean the complete disappearance of the nation (Maldives 2001).

Sea level rise, increasing sea surface temperatures and acidification of the oceans will entail a loss of mangrove forests and coral reefs and reduced fish stocks throughout this region. For example, studies have projected that 3 per cent of Cuba's mangrove forests may be lost with a one meter rise in sea level. For the same rise in sea level a complete collapse of the Port mangrove wetland in Jamaica is predicted, since this system has shown little capacity to migrate over the last 300 years (Nurse *et al.* 2001).

Climate change is also likely to have a negative effect on tourism in SIDS, seriously affecting the economy of many small islands. The increasing frequency and severity of extreme weather, sea-level rise and accelerated beach erosion, degradation of coral reefs (including bleaching), and the loss of cultural heritage on the coasts through inundation and flooding are likely to reduce the attractiveness of small island States to tourists. For example, in Barbados 70 per cent of the hotels are located within 250 m of the high water mark. This suggests that many hotels are almost exclusively within the 1 in 500 and 1 in 100 inundation zones, placing them at risk of major structural damage.<sup>20</sup>

<sup>20</sup> "Preliminary review of the economic impact of climate change on Caribbean Tourism: what is at risk and adapting for sustainable tourism development", presentation given by Ms. Marlene Attz at the Organization of American States Meeting on Adaptation to Climate Change in the Caribbean, Tourism Sector Workshop held in Grenada, in May 2002.





## V. ADAPTATION TO CLIMATE CHANGE

Adaptation to climate change in developing countries is vital and has been highlighted by them as having a high or urgent priority. Although uncertainty remains about the extent of climate change impacts, in many developing countries there is sufficient information and knowledge available on strategies and plans to implement adaptation activities now.

However, developing countries have limitations in capacity making adaptation difficult. Limitations include both human capacity and financial resources. Outputs from the UNFCCC workshops and meeting highlighted that the most effective adaptation approaches for developing countries are those addressing a range of environmental stresses and factors. Strategies and programmes that are more likely to succeed need to link with coordinated efforts aimed at poverty alleviation, enhancing food security and water availability, combating land degradation and reducing loss of biological diversity and ecosystem services, as well as improving adaptive capacity. Sustainable development and the Millennium Development Goals are a necessary backdrop to integrating adaptation into development policy. Reduction policies are also important elements of adaptation.

This chapter explores adaptation in developing countries. The lack of funding available in various forms, as well as difficulties in accessing the funds which are available, represents a major barrier for adaptation, particularly for local community action. International financial mechanisms, including possible novel mechanisms for adaptation are explored. It is recognised that research and training to enable adaptation is needed in developing countries in order to help understand climate change impacts and vulnerabilities and facilitate better policy decisions and management. Many developing countries face difficulties in integrating climate change concerns into national policies due to a lack of resources and institutional capacities. Capacity-building, for example to integrate climate change and socio-economic assessments into vulnerability and adaptation assessments, helps to better identify effective adaptation options and their associated costs. The chapter looks at adaptation in the

light of sustainable development, the integration of adaptation into policy and development planning, and the need for further capacity-building and training. Given that many countries may experience similar effects from climate change, sharing experience can broaden knowledge on how to address the adaptation challenges. In this regard South-South and North-South cooperation on adaptation is an effective way of promoting the implementation of adaptation measures. A number of current collaborations are discussed which are helping to pave the way for cooperation on climate change adaptation.

A final section on implementing adaptation looks at suggestions from the UNFCCC workshops and meeting in 2006 – 2007 on a number of ways forward for the Conference of the Parties to the UNFCCC and the international community to consider in implementing adaptation action.

### 5.1 ADAPTATION STRATEGIES, PLANS AND PROGRAMMES

Adapting to climate change will entail adjustments and changes at every level – from community to national and international. Communities must build their resilience, including adopting appropriate technologies while making the most of traditional knowledge, and diversifying their livelihoods to cope with current and future climate stress. Local coping strategies and traditional knowledge need to be used in synergy with government and local interventions. The choice of adaptation interventions depends on national circumstances. To enable workable and effective adaptation measures, ministries and governments, as well as institutions and non-government organizations, must consider integrating climate change in their planning and budgeting in all levels of decision making.

In [CHAPTER IV](#) the impacts and vulnerabilities of developing countries to climate change were highlighted in terms of the sectors affected. One way of grouping adaptation options is to identify whether they are sectoral, cross-sectoral or multi-sectoral.

Sectoral adaptation measures look at actions for individual sectors that could be affected by climate change. For example, in agriculture, reduced rainfall and higher evaporation may call for the extension of irrigation; and for coastal zones, sea level rise may necessitate improved coastal protection such as reforestation. Often adaptation measures in one sector will involve a

strengthening of the policy that already exists, emphasizing the importance of including long term climate change considerations along with existing local coping mechanisms and integrating them into national development plans.

Multi-sectoral adaptation options relate to the management of natural resources which span sectors, for example, integrated management of water, river basins or coastal zones. Linking management measures for adaptation to climate change with management measures identified as necessary from the other Rio Conventions: the Convention on Biological Diversity and the United Nations Convention to Combat Desertification; could be a useful multi-sectoral approach which addresses a range of environmental stresses.

Cross-sectoral measures also span several sectors and can include: improvements to systematic observation and communication systems; science, research and development and technological innovations such as the development of drought-resistant crop varieties or new technologies to combat saltwater intrusion; education and training to help build capacity among stakeholders; public awareness campaigns to improve stakeholder and public understanding on climate change and adaptation; strengthening or making changes in the fiscal sector such as new insurance options; and risk/disaster management measures such as emergency plans. For example, Bhutan's NAPA provides an example of a cross-sectoral adaptation project. It identifies the need for a forecasting and early warning system to provide seasonal forecasts for supporting agricultural production decisions and provide an early warning system and disaster management strategy for food security and emergency medicine to vulnerable communities in the case of extreme events (Bhutan 2006).

Adaptation to climate change must also occur through the prevention and removal of maladaptive practices. Maladaptation refers to adaptation measures that do not succeed in reducing vulnerability but increase it instead. Examples of measures that prevent or avoid maladaptation include: better management of irrigation systems; and removal of laws that can inadvertently increase vulnerability such as destruction of mangroves and relaxation of building regulations on coasts and in floodplains.

Parties to the UNFCCC have all agreed to undertake national adaptation measures and cooperate in preparing for the impacts of climate change. The UNFCCC plays an important catalytic role in promoting the development of adaptation strategies and plans. The UNFCCC secretariat developed a compendium on methodologies

for assessing vulnerability and adaptation,<sup>21</sup> and a database on existing local coping strategies to climate variability and hazards, which can be replicated in countries which are now facing similar threats as these but due to climate change.<sup>22</sup> The Nairobi work programme<sup>23</sup> is fostering knowledge exchange among the research and stakeholder communities to help countries make informed decisions on practical adaptation options. The initial activities of the Nairobi work programme during 2007–2008 involve workshops and reports on nine key areas of work: methods and tools; data and observations; climate modelling, scenarios and downscaling; climate related risks and extreme events; socio-economic information; adaptation planning and practices; research; technologies for adaptation; and economic diversification. Outcomes of the Nairobi work programme are expected to lead to enhanced knowledge on adaptation options at all levels and integration of actions into planning and sustainable development.

In their national communications to the UNFCCC, developing countries provided information on their vulnerabilities to climate change for a wide range of sectors. The main sectoral adaptation options and responses highlighted by developing countries to adapt to climate change in these different sectors are provided in [TABLE V-5](#). These include both reactive and anticipatory responses to climate change. Reactive responses are those which are implemented as a response to an already observed climate impact whereas anticipatory responses are those that aim to reduce exposure to future risks posed by climate change.

As shown by the national communications, the range of practices that can be used to adapt to climate change is diverse. The effectiveness of a practice tends to depend on location and socio-economic situation, but that does not prevent practices from being shared, replicated and improved. Work on adaptation planning and practices under the Nairobi work programme has highlighted a number of adaptation approaches, strategies, practices and technologies at the regional, national, and local levels in different sectors (UNFCCC 2007h). Two examples from Indonesia as provided by submissions by the ISDR secretariat and the International Research Institute for Climate and Society (IRI) highlight: building a monitoring system for food security and livelihood through Community Based Disaster Risk Management to prevent food shortage in the eastern part of Nusa Tenggara; and a fire early response system in Central Kalimantan to include analysis of links between climate and fires, identify policy links and develop and test tools to support fire management.

**Table V-5. Adaptation measures in key vulnerable sectors highlighted in national communications of developing countries**

Vulnerable sectors	Reactive adaptation	Anticipatory adaptation
Water Resources	<ul style="list-style-type: none"> <li>- Protection of groundwater resources</li> <li>- Improved management and maintenance of existing water supply systems</li> <li>- Protection of water catchment areas</li> <li>- Improved water supply</li> <li>- Groundwater and rainwater harvesting and desalination</li> </ul>	<ul style="list-style-type: none"> <li>- Better use of recycled water</li> <li>- Conservation of water catchment areas</li> <li>- Improved system of water management</li> <li>- Water policy reform including pricing and irrigation policies</li> <li>- Development of flood controls and drought monitoring</li> </ul>
Agriculture and food security	<ul style="list-style-type: none"> <li>- Erosion control</li> <li>- Dam construction for irrigation</li> <li>- Changes in fertilizer use and application</li> <li>- Introduction of new crops</li> <li>- Soil fertility maintenance</li> <li>- Changes in planting and harvesting times</li> <li>- Switch to different cultivars</li> <li>- Educational and outreach programmes on conservation and management of soil and water</li> </ul>	<ul style="list-style-type: none"> <li>- Development of tolerant/resistant crops (to drought, salt, insect/pests)</li> <li>- Research and development</li> <li>- Soil-water management</li> <li>- Diversification and intensification of food and plantation crops</li> <li>- Policy measures, tax incentives/subsidies, free market</li> <li>- Development of early warning systems</li> </ul>
Human health	<ul style="list-style-type: none"> <li>- Public health management reform</li> <li>- Improved housing and living conditions</li> <li>- Improved emergency response</li> </ul>	<ul style="list-style-type: none"> <li>- Development of early warning system</li> <li>- Better and/or improved disease/vector surveillance and monitoring</li> <li>- Improvement of environmental quality</li> <li>- Changes in urban and housing design</li> </ul>
Terrestrial ecosystems	<ul style="list-style-type: none"> <li>- Improvement of management systems including control of deforestation, reforestation and afforestation</li> <li>- Promoting agroforestry to improve forest goods and services</li> <li>- Development/improvement of national forest fire management plans</li> <li>- Improvement of carbon storage in forests</li> </ul>	<ul style="list-style-type: none"> <li>- Creation of parks/reserves, protected areas and biodiversity corridors</li> <li>- Identification/development of species resistant to climate change</li> <li>- Better assessment of the vulnerability of ecosystems</li> <li>- Monitoring of species</li> <li>- Development and maintenance of seed banks</li> <li>- Including socioeconomic factors in management policy</li> </ul>
Coastal zones and marine ecosystems	<ul style="list-style-type: none"> <li>- Protection of economic infrastructure</li> <li>- Public awareness to enhance protection of coastal and marine ecosystems</li> <li>- Building sea walls and beach reinforcement</li> <li>- Protection and conservation of coral reefs, mangroves, sea grass and littoral vegetation</li> </ul>	<ul style="list-style-type: none"> <li>- Integrated coastal zone management</li> <li>- Better coastal planning and zoning</li> <li>- Development of legislation for coastal protection</li> <li>- Research and monitoring of coasts and coastal ecosystems</li> </ul>

Source: National communications of non-Annex I Parties<sup>24</sup> and UNFCCC Sixth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention. Note by the secretariat. Addendum 5. Climate change impacts, adaptation measures and response strategies<sup>25</sup>

<sup>21</sup> <<http://unfccc.int/2674.php>>

<sup>22</sup> <<http://maindb.unfccc.int/public/adaptation>>

<sup>23</sup> <<http://unfccc.int/3633.php>>

<sup>24</sup> <<http://unfccc.int/2979.php>>

<sup>25</sup> <<http://unfccc.int/resource/docs/2005/sbi/eng/18a05.pdf>>

Planning for climate change must involve consideration of climate related risks including those which have a slow onset, such as changes in temperature and precipitation leading to agricultural losses and drought and biodiversity losses, and those which happen more suddenly such as tropical storms and floods. It is now recognized that climate-related risks are already happening and past and current experiences in dealing with climate variability and extreme events provide valuable information for reducing vulnerability and enhancing resilience to future climate-related adverse impacts. The disaster risk reduction community already has a strong body of experience in dealing with climate-related risks. The global disaster management community, as well as sectoral communities, are increasingly focusing their efforts on building resilience into investments and development. Where necessary risk reduction needs to be built into adaptation plans to help plan for and cope with future climate variability and extreme events. Work under the Nairobi work programme in this area has already started (UNFCCC 2007m).

For all regions, as highlighted at the workshops, there is a need to enhance technical capacity to assess, plan and integrate adaptation needs into sectoral development plans; and to support integration of adaptation into sectoral policy, particularly in the areas of water, agriculture, coastal zones and managing natural ecosystems. Needs-based regional technology transfer is an important area in helping countries to adapt (UNFCCC 2007g). Technology transfer can include “hard” forms of technology, such as new irrigation systems or drought-resistant seeds, or “soft” technologies, such as insurance schemes or crop rotation patterns; or they can involve a combination of hard and soft, as with early warning systems that combine hard measuring devices with soft knowledge and skills that can raise awareness and stimulate appropriate action. Submissions to the UNFCCC secretariat by Parties and relevant organizations through the Nairobi Work Programme reported a number of technologies for adaptation (UNFCCC 2007k) including hard technologies such as sea walls in Male Island, in the Maldives; soft technologies such as low-cost irrigation, embankment cropping, floating gardens and integrated farming systems in Bangladesh. Mexico also commends combining soft and hard technologies in the development of risk atlases and early warning systems, which have resulted in greater attention and resource allocation to risk prevention.

Another important adaptation strategy is economic diversification within sectors to reduce dependence on climate-sensitive resources, particularly for countries that rely on narrow ranges of climate-sensitive economic

activities, such as the export of a climate-sensitive crop. For example coffee in Uganda, a vital source of income for the country, will suffer drastic reduction in suitable growing areas under climate change (UNFCCC 2007b). Economic diversification is being discussed within the context of UNFCCC negotiations (see document FCCC/SBI/2007/15, UNFCCC 2007i), and through the Nairobi Work Programme (UNFCCC 2007l).

A significant move by the UNFCCC process was to enable least developed countries to identify their immediate priorities for adaptation options via the National Adaptation Programmes of Action<sup>26</sup> which identify their urgent and immediate adaptation needs – those for which further delay could increase vulnerability or lead to increased costs at a later stage. Over 40 least developed countries have received funding under the Convention to prepare their NAPAs which draw on existing information and community-level input to prioritize adaptation plans. Many countries have already submitted their NAPAs to the UNFCCC secretariat.<sup>27</sup>

Priority adaptation projects identified by NAPAs include:

- improved forecasting for farming, extreme events and disaster management;
- improved water management for drinking and agriculture through understanding water flows and water quality, improved rainwater harvesting and water storage and diversification of irrigation techniques;
- improved food security through crop diversification, developing and introducing drought, flood and saline-tolerant crops, improving livestock and fisheries breeding and farming techniques, developing local food banks for people and livestock, and improving local food preservation;
- better land and land use management through erosion control and soil conservation measures, agroforestry and forestry techniques, forest fire management and finding alternative energy sources to wood and charcoal, as well as better town planning;
- coastal zone management including coral monitoring and restoration and improving coastal defences through afforestation, reforestation, set-back areas and vegetation buffers;
- improved health care through flood shelters and assistance shelters as part of community emergency preparedness programmes, better health education, better access to primary health care such as distribution of treated mosquito nets and better malaria surveillance programmes and habitat clearance;
- capacity-building to integrate climate change into sectoral development plans, involving local communities in adaptation activities, raising public awareness and

education on climate change, and enabling representation at international meetings;

- and promotion of sustainable tourism.

Given the good experiences so far with NAPA preparation, it was suggested at the workshops and meeting to extend NAPAs to more developing countries in order to help them identify their priority needs and plans for adaptation.

As well as projects planned via the NAPA process, a number of other adaptation projects have also been planned, and some implemented, by and in developing countries at a number of levels. Adaptation projects have been funded by the UNFCCC process through the Global Environment Facility (GEF), via governments, and from national and international bilateral and multilateral agencies and organizations.

Bilaterally funded projects are already providing capacity-building for adaptation. At the workshops and expert meeting, several of these projects were highlighted. These include work by developing country governments, bilateral and multilateral agencies to assess local vulnerability and adaptation as well as, in some cases, integrate work on adaptation into development and policy planning.

In the Africa workshop, a representative from the Food and Agriculture Organization (FAO) reported that FAO has produced CD ROMs on tools and models relevant to adaptation in the agriculture sector, and has also made this information available on the Internet.<sup>26</sup> In addition, FAO conducts training workshops to build related capacity. The background paper to the workshop (UNFCCC 2006c) reports on a number of capacity-building projects including a series of GEF funded projects to assist African communities to assess risks and options to adopt to drought, coastal flooding and health risks, such as Coping with Drought and Climate Change (in Mozambique, Zimbabwe and Ethiopia) and Adaptation to Climate and Coastal Change in West Africa (ACCC) (in Senegal, Cape Verde, Guinea Bissau, Gambia and Mauritania).

Mentioned in the Asia workshop was a study by the United Nations Environment Programme (UNEP) and the International Centre for Integrated Mountain Development in the Himalayan region, which aims to establish an inventory of glacial lakes, a monitoring and early warning system and adaptation measures for this region. Mongolia mentioned its National Action Programme on climate change, which includes evaluating concrete and practical adaptations that could possibly decrease the livestock sector's vulnerability to climate change. The Asia

background paper (UNFCCC 2007b) highlights a number of capacity-building projects funded by the GEF and other sources including the Asia-Pacific Network for Global Change Research; Practical Action; SouthSouthNorth and the Netherlands, Canadian and UK governments. For example, a project by the Asia-Pacific Network for Global Change Research is helping to build adaptive capacity in southeast Asia by contributing to building better theories and models of resilience and adaptive capacity and develop improved awareness among decision makers in business, government and resource management agencies (Cambodia, China, India, Indonesia, Japan, Lao PDR, Malaysia, Philippines, Thailand, Viet Nam).

In Latin America the Capacity-Building Project for Stage II adaptation to climate change in Central America, Mexico and Cuba plans to help prepare adaptation plans and strategies in participating countries. Capacity-building and training for model development to help understand climate change has been provided by the UK Hadley Centre's PRECIS initiative which was highlighted by participants. Another initiative started by Brazil involves training on the regional model ETA developed by the Centro de Previsao de Tempo e Estudos Climaticos. An important issue in Latin America is that of glacial melt in the Andes, a project currently being funded by GEF will design and implement adaptation measures to address glacial melt in the central Andes, Bolivia, Ecuador and Peru (UNFCCC 2006b).

At the SIDS meeting, a representative of the Caribbean Community Climate Change Centre (CCCCC) gave two examples of projects dealing with adaptation. The Mainstreaming Adaptation to Climate Change project carries out vulnerability assessments for communities at risk, exploring their history and possible climate change impacts in order to design adaptation options with the aim of influencing adaptation policy. Assessments are being undertaken in the tourism sector in Barbados and in the agriculture sector in Guyana, and may also be undertaken in Jamaica and Belize in the water resources sector. The Special Pilot on Adaptation to Climate Change supported by the GEF, 2007 – 2011, is being undertaken in three SIDS (Dominica, St. Lucia, and St. Vincent and the Grenadines) to implement specific pilot adaptation measures addressing the impacts of climate change on biodiversity and land degradation. A representative from the Pacific Regional Environment

<sup>26</sup> <<http://unfccc.int/2719.php>>

<sup>27</sup> As of 1 September 2007, 21 countries had submitted their NAPAs to the UNFCCC

<sup>28</sup> <<http://www.fao.org/nr/climpag>>

Programme (SPREP) mentioned the Pacific Islands Framework for Action on Climate Change 2006 – 2015 endorsed by leaders. This establishes sets of priorities for action on climate change in the region and involves local, national, regional and international levels. Adaptation is focused on: multi-stakeholder engagement, risk management, no regrets, and improving safe secure livelihoods; with a particular focus on the most vulnerable areas and on integration into national strategies. Kiribati is one of the world's most vulnerable countries, spread over 33 low-lying atolls in the central and western Pacific region. The Kiribati adaptation programme, funded by GEF, is providing vulnerable communities with the information and means to enhance adaptive capacity, including improved management, conservation, restoration and sustainable use of biodiversity, improved protection and management of mangroves and coral reefs, and integrating adaptation into government economic planning.

Representatives at the workshops and meeting also highlighted global and inter-regional capacity-building projects. These include a WHO/UNDP/GEF pilot project on adaptation policies and programmes for developing countries to design and implement measures to protect health<sup>29</sup> (Barbados, Fiji, Uzbekistan, Jordan, Bhutan, Kenya, China) and the Community-based Adaptation (CBA) Programme, which is funded by GEF and provides capacity-building for adaptation planning through community level consultations in a number of countries (Bangladesh, Bolivia, Niger, Samoa, Guatemala, Jamaica, Kazakhstan, Morocco, Namibia, Viet Nam). The Assessments of Impacts and Adaptations to Climate Change (AIACC) global initiative is implemented by the United Nations Environment Programme and executed jointly by the global change SysTem for Analysis, Research and Training (START) and the Third World Academy of Sciences, and funded by the GEF.<sup>30</sup> This project involving 46 developing countries aims to advance scientific understanding of climate change vulnerabilities and adaptation options in developing countries and has carried out regional assessments in Africa, Asia, Latin America and SIDS, identifying nine key messages for adaptation: adapt now, create conditions to enable adaptation, integrate adaptation with development, increase awareness and knowledge, strengthen institutions, protect natural resources, provide financial assistance, involve those at risk, and use place specific strategies (AIACC 2007).

Also given at the workshops and meeting were specific examples of adaptation projects that go beyond capacity-building to implement actual adaptation activities on the ground. These include a number of community-based adaptation plans and projects. These bottom-up initiatives

include community-based water harvesting or allocation systems, supplying mosquito nets, and community-based disaster risk reduction. Participants noted that, from a country perspective, community based approaches provide the most effective capacity-building for practical adaptation actions through implementation and a 'learning by doing' process. Community-based adaptation is an important tool for developing adaptation options and it is important to share the knowledge gained from these experiences. The community based adaptation exchange (CBA-X)<sup>31</sup> run by the Eldis Programme, UK, in collaboration with the International Institute for Environment and Development is a shared resource supporting the exchange of up-to-date and relevant information about community-based climate adaptation.

Further specific adaptation examples from the Africa workshop include that reported by Benin on soft technology adaptation techniques where seedling transplantation is being used to adapt to floods: before the rainy season, fields are prepared and, in cases of predicted flooding, seedlings are transplanted to the nursery. In Tanzania increased drought has forced farmers to avoid the risk of planting a single crop and they now plant a number of crop varieties and species on the same land. The Sustainable Land Use and Forestry/USAID programs in Africa (UNFCCC 2006c) help mitigate climate change by absorbing and storing carbon dioxide from the atmosphere, promoting biodiversity conservation and improving forest management, and sustainable agriculture.

At the Asia workshop, a representative from the Philippines reported on the national Community Based Flood Early Warning System which aims at helping local communities prevent losses from increasing floods. Policy measures employed include coordination with the local government, organizing training, sharing information, monitoring rain and water levels, mapping and providing legislative support to local communities. The lessons learned from the CBFews that can be replicated for many community-based adaptation activities include the importance of involving grassroots organizations, transferring decision-making power to local communities; and combining advanced technologies with indigenous knowledge. The project also identified needs in relation to scientific, technological and policy aspects, including improved climate and water modelling of climate change impacts on the water cycle, environmental impact assessments and flood management; better communication between the scientific community and various stakeholders, and enhanced regional collaboration using a common flood management protocol.

In Latin America, examples of adaptation activities include a GEF funded project in Ecuador which collaborates with the Waorani and Timpoca communities to create a sustainable management plan of raising palms and frogs to earn income. In Brazil, SouthSouthNorth have a number of adaptation projects which are helping agricultural productivity, reforestation and recovery of degraded land.

In SIDS, adaptation has mostly been taking place through individual, ad-hoc actions on a local scale. For example, placing concrete blocks on the top of zinc roofs to prevent the roofs from being blown away during hurricanes has become common practice in Jamaica since Hurricane Ivan. In Vanuatu, SPREP, with funding from the Canadian government, has moved 100 villagers living in the Lateu settlement to higher ground 600 m from the coast and 15 m above current sea level (UNFCCC 2007a).

A recent analysis of completed, ongoing or planned adaptation projects that have adaptation as a stated objective, and for which information is publicly available, was undertaken by the UNFCCC secretariat. This list is relatively short, only about 180 identified projects have been identified so far.

Despite all positive efforts in the assessment of vulnerability and adaptation, the movement from adaptation assessment and planning to implementation is not well developed. At the regional workshops and expert meeting on adaptation, it was pointed out that, whereas a number of countries have well-developed adaptation plans or are in the process of finalising them, many more resources are needed for implementation. The Andean Community of Nations, for example, developed an adaptation plan in 2004, but no concrete actions have been taken so far towards its implementation (UNFCCC 2006d). A lot of projects being implemented at the moment deal with capacity-building for adaptation. The lessons learnt from these need to be communicated at every level. The national communications and NAPAs highlight a large number of priority adaptation options. It is important now to enable and fund the implementation of these plans and projects.

## 5.2 LOCAL COPING STRATEGIES

There is a large body of knowledge and experience within local communities on coping with climatic variability and extreme weather events. Local communities have always aimed to adapt to variations in their climate. To do so, they have made preparations based on their resources

and their knowledge accumulated through experience of past weather patterns. This includes times when they have also been forced to react to and recover from extreme events, such as floods, drought and hurricanes.

Local coping strategies are an important element of planning for adaptation. Climate change is leading communities to experience climatic extremes more frequently, as well as new climate conditions and extremes. Traditional knowledge can help to provide efficient, appropriate and time-tested ways of advising and enabling adaptation to climate change in communities who are feeling the effects of climate changes due to global warming. Several examples of local coping strategies are mentioned in the background papers to the workshops (UNFCCC 2006b, 2006c, 2007a, 2007b).

In Africa rural farmers have been practicing a range of agricultural techniques as coping strategies and tactics to enable sustainable food production and deal with extreme events. These include intercropping and crop diversification; use of home gardens, diversification of herds and incomes, such as the introduction of sheep in place of goats in the Bara province in Western Sudan, pruning and fertilizing to double tree densities and prevent soil erosion in semi-arid areas, e.g. Senegal, Burkina Faso, Madagascar and Zimbabwe; manipulation of land use leading to land use conversion, e.g. a shift from livestock farming to game farming in Southern Africa; water conservation techniques to cope with arid conditions such as the Zaï technique in Burkina Faso: farmers dig pits in the soil to collect organic material carried by the wind during the dry season, at the start of the rainy season farmers add organic matter from animals which attracts termite activity resulting in termite tunnels that can collect rain deep enough that it doesn't evaporate, and thus increasing soil fertility. In many locations tribal and individual movements and migration are also identified as adaptation options.

In Asia, farmers have traditionally observed a number of practices to adapt to climate variability, for example intercropping, mixed cropping, agro-forestry, animal husbandry, and developing new seed varieties to cope with local climate. Various water use and conservation strategies include terracing, surface water and groundwater irrigation; and diversification in agriculture to deal with drought. Structural and non-structural measures are used

<sup>29</sup> <<http://www.who.int/globalchange/climate/gefsummary.pdf>>

<sup>30</sup> <<http://www.aiaccproject.org/aiacc.html>>

<sup>31</sup> <<http://www.cba-exchange.org>>

to deal with flood and coastal inundation. For example, in the Philippines, after Typhoon Sisang in 1987, which completely destroyed over 200,000 homes, the Department of Social Welfare and Development decided to instigate a programme of providing typhoon-resistant housing designed to withstand wind speeds of 180 km/h for those living in the most typhoon prone areas. In Bangladesh, the Cyclone Preparedness Program has been set up over 11 coastal area districts by the Bangladesh Red Crescent Society, and is partly funded by the government. Volunteers have been trained to help in cyclone warning, evacuation, rescue, first aid emergency relief and the use of radio communication equipment.

In Latin America, local coping strategies include a variety of agricultural practices, ecosystem protection and methods to adapt to extreme events. Farmers in Peru have been using an ancient irrigation and drainage system “waru waru”, or raised field agriculture, which makes it possible to bring into production the low-lying, flood-prone, poorly drained lands found all over the Altiplano. The shallow canals provide moisture during droughts and drainage during the rainy season. When filled with water they also create a microclimate that acts as a buffer against night time frosts. The waru waru system provides farmers with greater harvest security and reduces the risks associated with frosts and drought. In Mexico, the Cajete Terrace agroecosystems have been in place for three thousand years in hillside regions in Tlaxcala. In these rainfed Corn–Bean–Squash agroecosystems, food is grown on steep erosion-prone slopes. Rainfall is concentrated between May and September and often occurs in sudden downpours. Sloping terraces feed excess water into tanks (cajetes). The water, which would otherwise not be absorbed into the soil, is collected inside the cajetes and slowly percolates into the surrounding soils after the rain has ended. Eroded soils are also trapped inside the cajetes, preventing soil loss down the slope. Nutrient rich soils inside of the cajetes are later gathered and distributed into the fields. The Aymaran indigenous people of Bolivia have been coping with droughts through the construction of small dams “qhuthañas”. These dams collect and store rainwater from 50 to 10,000 cubic meters. In El Salvador communities employ a number of soil conservation measures to cope with recurrent droughts, for example building barriers consisting of stone and pine suckers, which provide edible fruits and additional income. In Costa Rica and Ecuador local communities have improved their housing design to better cope with floods and droughts. Houses are either elevated or have a reinforced concrete strip as a foundation so that the bamboo walls do not touch the ground and are protected from fungal deterioration. These houses are cost-efficient and last longer than regular houses.

In SIDS, coping strategies include agricultural techniques, coral reef protection and coping with climate extremes. For example, on Timor Island farmers have developed their own varieties of major staple crops to adapt to erratic rainfall and cyclones and to ensure food security. Practices for coping with coastal erosion include community relocation. For example at Playa Rosaria, Havana Province, Cuba, the community has been relocated five kilometres inland because of coastal erosion. Other less disruptive activities such as reconstructing groynes, building sand dune fences, and planting trees along the coast can also reduce the impact of coastal erosion on communities.

The UNFCCC database on local coping strategies is a tool that enables sharing of information to help community based adaptation. It provides a collection of long-standing coping strategies, mechanisms, knowledge and experience from communities in developing countries that have had to adapt to specific hazards or climatic conditions. This database is available on the internet <<http://maindb.unfccc.int/public/adaptation>> and can be searched by climate hazard, impact or coping strategy. This knowledge can be used by communities that may just be starting to experience such conditions as a result of climate change. For example, searching for information on the climate hazard drought, provides a list of corresponding adaptation actions and associated case studies. Accessing adaptation action on Integrated agriculture-aquaculture will provide a case study on rice-fish farming on West Java. Clicking on the link provides a short summary on the coping practice, details on resource requirements, non-climate benefits and potential maladaptation, as well as contact information and links to relevant files and web sites.

### 5.3 FUNDING FOR ADAPTATION

Funding is vital in order for developing countries to plan for and implement adaptation plans and projects. A basic conclusion of the Stern Review is that the costs of strong and urgent action on climate change will be less than the costs thereby avoided of the impacts of climate change under business as usual (Stern 2006). All countries, rich and poor, need to adapt to climate change, and this will be costly. Developing countries, already the hardest hit by climate change, have little capacity (both in terms of human capacity and financial resources) to adapt. Financial ways and means must be found to enable developing countries to enhance their efforts to adapt. At the workshops and meeting the lack of funding available for adaptation was highlighted as a large impediment to implementing adaptation plans. Accessing the funds which

are available at present was identified as complex and lengthy. Even if this process were to be streamlined, a lot more funding would still be required for adaptation. New international financial mechanisms to provide a sustained and sufficient response to adaptation are needed.

At the workshops and meeting, participants emphasised the need for sustained financing for adaptation. Without sustained funding, adaptation runs the risk of not being effectively addressed, and largely limited to “reactive” funding, such as short-term emergency relief. This would be unresponsive of sustainable development and ultimately prove to be very costly. Funding is required for all developing countries to develop national adaptation strategies or action plans. These plans should exist at all levels: local, provincial and national.

Article 4 of the Convention highlights that developed country Parties shall provide financial resources to assist developing country Parties adapt to climate change. To facilitate this, the Convention assigned to the GEF the responsibility of operating its financial mechanism.<sup>32</sup> The GEF enables a transfer of financial resources from developed to developing countries by establishing operational programmes, providing programming documents and allocating resources. Based on guidance from the UNFCCC, the GEF operates three funds.<sup>33</sup> These are the GEF Trust Fund; the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). Further funding opportunities currently available for developing countries to fund adaptation projects include: the future Adaptation Fund under the Kyoto Protocol, funds from other multilateral environmental agreements (MEAs), and bilateral and multilateral funding from governments, national and international organizations and agencies.

The GEF Trust Fund and its Strategic Priority on Adaptation (SPA) support enabling activities and pilot and demonstration projects that address adaptation and at the same time generate global environmental benefits. COP guidance on GEF support for adaptation identified three stages. Stage I provided support for the national communications process, a portion of which is the vulnerability and adaptation assessment. Stage II provides further assistance for other capacity-building efforts for adaptation. Stage III refers to support for actual adaptation activities, including insurance. In 2001, the GEF established the Strategic Priority on Adaptation (SPA). The GEF has allocated USD 50 million under SPA of which USD 5 million has been devoted to piloting community adaptation initiatives through the Small Grants Programme (SGP). For example, the Special Program on Adaptation to Climate

Change in coastal areas aims to support participating countries (Dominica, St. Lucia and St. Vincent and the Grenadines) in implementing pilot adaptation measures, where climate change mainstreaming activities have already occurred. Activities will specifically address the impacts of climate change on biodiversity and land degradation at the coast. The Community based adaptation programme is aimed at developing a framework that spans all levels from local to intergovernmental to respond to unique community-based adaptation needs; identify and finance diverse community-based adaptation projects in a number of selected countries (Bangladesh, Bolivia, Niger, Samoa, Guatemala, Jamaica, Kazakhstan, Morocco, Namibia, Viet Nam); and disseminate lessons learned at the community level to all stakeholders, including governments.

The Special Climate Change Fund (SCCF) is partly designed to finance adaptation activities that increase resilience to the impacts of climate change, through a focus on adaptation responses particularly in water resources, land, agriculture, health, infrastructure development, disaster preparedness, and in fragile ecosystems and coastal zones. Funding will be available for establishing pilot or demonstration projects to show how adaptation planning and assessment can be practically translated into projects that will provide real benefits, and may be integrated into national policy and sustainable development planning, on the basis of information provided in the national communications, or of in-depth national studies, including NAPAs. For example, an SCCF project in Tanzania is aimed at incorporating Climate Change into integrated Water Resources Management in the Pangani River Basin; and in Ecuador an SCCF project is enabling adaptation to climate change through effective water governance.

The Least Developed Countries Fund (LDCF) was partly established to support projects addressing urgent and immediate adaptation needs in the least developed countries as identified by their National Adaptation Programmes of Action (NAPAs). The LDCF supports a learning-by-doing approach to adaptation. Projects proposed in the NAPAs which are being considered for LDCF funding include a coastal afforestation community based adaptation project in Bangladesh; a project to integrate climate change risks into community-based livestock management in the northwest lowlands of Eritrea; and a project to reduce climate change-induced risks and vulnerabilities from glacial lake outburst floods in the Punakha-Wangdi and Chamkhar Valleys in Bhutan.

<sup>32</sup> <<http://www.thegef.org>>

<sup>33</sup> <[http://www.gefweb.org/projects/focal\\_areas/climate/documents/GEF\\_Support\\_for\\_Adaptation\\_to\\_Climate\\_Change.pdf](http://www.gefweb.org/projects/focal_areas/climate/documents/GEF_Support_for_Adaptation_to_Climate_Change.pdf)>

At the workshops and expert meeting developing country representatives expressed their concern with the complexity of current arrangements for accessing funds from the GEF. It was highlighted that procedures for accessing existing financial resources for adaptation remain complex and lengthy. Participants at the UNFCCC workshops and meeting emphasised the need for capacity-building and information on the financial mechanisms available to improve access to funding and to facilitate project preparation. Improving the access of developing countries to financial resources, including through streamlining guidelines for application and by assisting countries in the preparation of project proposals was thought important at all workshops and meeting.

Within the context of the UNFCCC, the international carbon market has emerged as a result of the Clean Development Mechanism established under the Kyoto Protocol. The Clean Development Mechanism allows industrialized countries to help generate funding for adaptation in developing countries in the context of sustainable development while providing them a cost-effective means of offsetting their greenhouse gas emissions. The mechanism enables approved emission-reducing projects in developing countries to earn certified emission reduction units, each equivalent to one tonne of carbon dioxide, which the project participants in the developing country can then sell to buyers in industrialized countries. These sustainable development projects range from wind farms to hydroelectric power stations and also include energy efficiency projects.

The Adaptation Fund under the Kyoto Protocol is intended to fund concrete adaptation projects and programmes in developing countries that are particularly vulnerable to the adverse effects of climate change. The source of this funding is intended to be from a 2 per cent levy on proceeds from Clean Development Mechanism projects (excluding those undertaken in least developed countries), as well as from other voluntary sources. The Adaptation Fund is yet to be operationalized. The actual amount of money that will be available from this fund is uncertain as it depends on the extent of use of the Clean Development Mechanism and on the price of carbon. The World Bank estimates that the Adaptation Fund is likely to total USD 100 – 500 million by 2012.

Multilateral Environmental Agreements (MEAs) whose areas of work could be synergetic with adaptation may also provide further funding for adaptation. These MEAs include the Convention on Biological Diversity, UN Convention to Combat Desertification and the Ramsar Convention on Wetlands. For example, the Central African Regional Program for the Environment funded by USAID aims to help mitigate climate change by

absorbing and storing carbon dioxide from the atmosphere, promoting biodiversity conservation and improving forest management, and sustainable agriculture, and help reduce the vulnerability of ecosystems.

Bilateral and Multilateral Funding includes funding of adaptation projects directly via inter-governmental organizations, national and local governments, institutions and non-governmental organizations. Examples include many community-based projects by non-governmental organizations aimed at improving agricultural practices, water resource supply and use, primary health care and energy supply in developing countries.

In 2007 the UNFCCC secretariat launched a project to review and analyze investment and financial flows relevant to the development of an effective and appropriate international response to climate change, with particular focus on developing country's needs, including their medium-to long-term requirements for investment and finance.<sup>34</sup> As part of this project, the secretariat assessed the investment flows needed in 2030 that will be necessary to meet adaptation requirements in several sectors. The global cost of adaptation to climate change is difficult to estimate as climate change adaptation measures will be widespread and heterogeneous. However, for all of the sectors examined, there is a substantial deficit in current investment and financial flows.

In 2030 the adaptation funds required were estimated at: USD 14 million for agriculture, forestry and fisheries; USD 11 billion for water resources; USD 5 billion for human health; USD 11 billion for coastal zones; and USD 8 – 130 billion for infrastructure. In summary, the UNFCCC secretariat estimated that the investment and financial flows needed for adaptation are likely to be tens of billions of dollars per year several decades from now and could be more than USD 100 billion per year. Other studies (World Bank 2006b, Oxfam 2007) also estimate adaptation costs at tens of billions of dollars per year.

The funds that are currently available under the Convention and the Kyoto Protocol are small compared to the magnitude of the needs identified by the UNFCCC. The financial resources available for adaptation in the funds currently operated by the GEF (Trust Fund, LDCF and SCCF) amounted to about USD 275 million as of August 2007. The Adaptation Fund could receive USD 80 – 300 million per year for the period 2008 – 2012. Assuming a share of proceeds for adaptation of 2 per cent continues to apply post 2012, the level of funding could be: USD 100 – 500 million per year for a low demand for the CDM; and USD 1 – 5 billion per year for a high demand. However, there is still a deficit in funding that needs to be filled.

## 5.4 INSURANCE

Climate change is a catalyst for rising costs for human health, the global economy and the Earth’s life support system. Disaster losses could reach over USD 1 trillion in a single year by 2040. Climate change presents challenges and even opportunities for the finance sector. Businesses will be affected by climate change and by policies to address it. From the perspective of sustainable development, insurance measures can be beneficial for many developing countries by transferring risk from climate change. At the workshops and expert meeting, one part of the finance sector, that of insurance, emerged as a high priority for developing countries in adapting to climate change. The SIDS expert meeting focussed particularly on insurance options.

According to the Convention (Article 4.8), insurance-related actions constitute one of the three main means of response to the adverse effects of climate change, alongside funding and technology transfer. They can enhance financial resilience to external shocks and provide a unique opportunity to spread and transfer risk. They may provide incentives for risk reduction and prevention while engaging the private sector in climate change response action.

One of the benefits of promoting insurance-related actions is that it may help advance efforts on quantifying risks and potential losses due to climate change. Minimizing risk can result in a reduction of the rates for insurance, which thereby become more affordable.

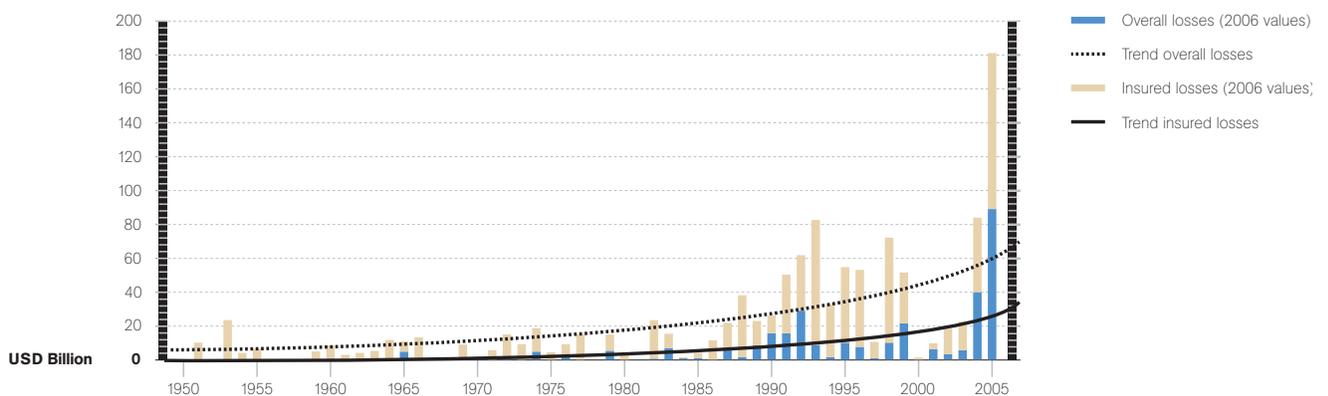
Rates could also reflect mitigation measures, such as implementation of hazard plans, forecasting and warning systems, undertaken by a community, individuals, governments, and other stakeholders.

As a result of climate change, there are both major challenges and opportunities for the insurance industry. The financial sector is already incurring additional costs from adverse climatic conditions, for example economic losses from extreme events are scaling new records (FIGURE V-2). The Insurance Working Group of the UNEP Finance Initiative<sup>35</sup> (UNEP FI) is a strategic and successful public-private partnership between UNEP and 16 leaders of the global financial sector. UNEP FI believe that the critical questions are “How can insurance assist developing countries grow more sustainably?” and “What are the principles for sustainable insurance?”. Their recent report explores the growing area of sustainable insurance (UNEP FI 2007).

Currently, the insurance market is very limited in developing countries, although it is a vital instrument for these countries, particularly for coastal communities and sectors such as tourism. Current limitations are, in part, due to limited economic assets and limited private sector interest in insurance. In SIDS this is compounded by their geographical size, relative isolation, and high risk of extreme weather events.

<sup>34</sup> <<http://unfccc.int/4053.php>>, <[http://unfccc.int/files/cooperation\\_and\\_support/financial\\_mechanism/financial\\_mechanism\\_get/application/pdf/dialogue\\_working\\_paper\\_8.pdf](http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_get/application/pdf/dialogue_working_paper_8.pdf)>  
<sup>35</sup> <<http://www.unepfi.org>>

Figure V-2. Economic losses from great weather disasters 1950 – 2006, overall and insured losses



Source: © NatCatSERVICE, Geo RiskResearch, Munich Re <[http://www.munichre.com/app\\_resources/pdf/ts/geo\\_risks/natcatservice/long-term\\_statistics\\_since\\_1950/MRNatCatSERVICE\\_1950-2006\\_Great\\_weather\\_disasters\\_Overall\\_insured\\_losses\\_en.pdf](http://www.munichre.com/app_resources/pdf/ts/geo_risks/natcatservice/long-term_statistics_since_1950/MRNatCatSERVICE_1950-2006_Great_weather_disasters_Overall_insured_losses_en.pdf)> [Last accessed 10 October 2007]

Participants at the workshops and SIDS expert meeting highlighted the need for the implementation of insurance schemes and finance services for risk sharing at different levels. Possible cost-effective insurance initiatives are highlighted in (Box V-3). A well-coordinated dialogue between the private sector and representatives from Parties would assess cooperative actions that could be carried out to increase the insurance coverage of populations affected by climate change. The banking sector must also be involved in the work relating to climate change insurance and mainstreaming adaptation, on the basis that many loans could be at risk because of the absence of climate-proofing in projects.

In response to the growing realization that insurance solutions can play a role in adaptation, as suggested in the UNFCCC and the Kyoto Protocol, the Munich Climate Insurance Initiative was initiated by Munich Re in April 2005.<sup>36</sup> This initiative, formed by insurers, climate change and adaptation experts, NGOs, and policy researchers aims to develop insurance-related solutions to climate change, including identifying and promoting loss reduction measures, in cooperation with other organizations and initiatives and conduct pilot projects.

Examples of insurance schemes in developing countries from which lessons could be learned includes a microinsurance scheme by the United Insurance Company Limited Hurricane Mitigation Programme,<sup>37</sup> which operates in 14 Caribbean countries. This Programme aims to reduce the vulnerability of Caribbean property to hurricanes

by providing financial incentives for insurance holders to put preventative measures in place. Microfinancing is also an option for hedging risk. In Bangladesh the microfinancing institutions, Proshika and Grameen, with their long acquaintance with the impacts of disasters on the poor, have started to promote loans to reduce vulnerability to climate change. Loans are available for safer housing, diversifying incomes, from agriculture and sharecropping to more disaster-proof activities and mobile assets, and for rapid credit to promote fast recovery immediately after a disaster. Loan officers and borrowers are also increasingly taking a role in community preparedness projects.

The case of the Caribbean Catastrophe Risk Insurance Facility (CCRIF) could be extrapolated and localized to the circumstances of other regions. It uses a portion of donor-funded capital reserves to assist in the establishment of a facility that assists countries in pooling their risk and reducing insurance costs. The CCRIF uses parametric cover which enables immediate claims payments to the country because payouts are linked to triggers, such as wind speed. Insurance premiums are tied to the risk profiles of individual countries. The advantages of this scheme include efficient risk transfer mechanisms, optimal pricing from reinsurance through risk-pooling and economies of scale, and sharing of administrative and operational costs of the insurance business. However, as risk profiles increase due to the impacts of climate change, premiums will also rise which will mean that small island States will need to bear the costs of additional risks associated with climate change.

**Box V-3. Possible cost-effective insurance initiatives for developing countries to help adaptation to climate change**

- Innovative risk transfer mechanisms such as multi-state risk pooling mechanisms;
- Regional reinsurance facilities, either through the private market or from the state, whereby the re-insurer assumes responsibility for covering a portion of the risk, especially for rare but extreme event losses;
- Catastrophe funds linked to international financial markets – that pay out on a trigger condition, such as temperatures over a certain value for a certain length of time, rather than on proof of loss;
- National/regional disaster funds supported financially by the international community;
- Micro-finance and micro-insurance;
- Public-private partnerships, such as the UNEP FI;
- Generation of carbon credits in exchange for support for insurance;
- Weather derivatives which provide payouts in response to weather triggers rather than in response to demonstrated losses;
- An international insurance pool – proposed by the Alliance of Small Island States in 1992, it was suggested that payments into an insurance pool would be a form of compensation linked to responsibility or liability for the impacts of climate change.

For many insurance options, national governments will need to support local governments through transfer of resources based on risk assessments by subregion. Public-private partnerships with financial institutions, that help promote preparedness and mitigation and short-term training programmes for community-based organizations, could be of great assistance in building capacity at a local level.

At the SIDS meeting, suggested ways forward include identifying specific issues and constraints relating to insurance, and engaging the insurance industry and finance experts on novel and innovative approaches to address insurance and relief funding in the context of risks relating to climate change. This could be done through expert meetings and/or workshops, perhaps bringing together actual practitioners and providers of insurance services with climate change stakeholders to devise appropriate responses to enhance the role of insurance as an adaptation tool for SIDS. This will require the involvement of non-SIDS countries to ensure practical risk distribution. Participants at the workshops and expert meeting suggested that the UNFCCC process could provide support to help identify possible insurance options and increase the resilience of countries to climate change. More information and assessment, including the expansion of early warning systems and information dissemination systems, and improvement in forecasting and disaster related decision-making would help to evaluate insurance options. The

Nairobi work programme can also provide a valuable opportunity for furthering methodological efforts relating to insurance in the context of climate change adaptation. The international community could provide support in the context of insurance in a number of ways (Box V-4).

<sup>36</sup> <<http://www.climate-insurance.org>>

<sup>37</sup> <<http://www.unitedinsure.com/united.cfm?LID=helpful%20info&SID=Hurricane%20Retrofitting>>

**Box V-4. Opportunities for the international community to support insurance-related solutions to climate change in developing countries**

The international community could contribute to identify actions aimed at:

**Supporting public private partnership:** by transferring (or arranging the transfer of) the risks of national or regional public-private insurance systems in the capacity of re-insurer or consider subsidizing the costs of alternative hedging instruments.

**Supporting relief and reconstruction:** by assisting governments in transferring their risks of public infrastructure damage either through private insurers or directly to the capital markets through alternative risk-transfer instruments.

**Supporting micro insurers:** by playing a possible role in supporting and transferring the risks of micro-insurers, for example those offering weather hedges, possibly by acting as reinsurer or assuming the interest payments of catastrophe bonds.

**Supporting data collection and analytical capacity-building:** by providing support to developing countries in collecting the requisite data and in building analytical capacity as any insurance or insurance-related system requires knowledge of these risks.

**Supporting new risk hedging instruments:** by creating national-level market incentives, for example tax reductions to individuals or institutions for purchasing developing country catastrophe bonds at lower interest.

## 5.5 SUSTAINABLE DEVELOPMENT PLANNING AND PRACTICES

Climate change has the potential to undermine sustainable development, increase poverty, and delay or prevent the realization of the Millennium Development Goals. An effective way to address the impacts of climate change is by integrating adaptation measures into sustainable development strategies so as to reduce the pressure on natural resources, improve environmental risk management, and increase the social well-being of the poor. Climate change can influence humans directly, through impacts on health and the risk of extreme events on lives, livelihoods and human settlements, and indirectly, through impacts on food security and the viability of natural resource-based economic activity. The workshops and meeting discussed the impacts of climate change on achievement of the Millennium Goals in the different regions (TABLE V-6).

Competition for scarce resources, such as fresh water, land or fishing grounds, brought about by changes in climate, has the added potential to cause conflict over resources with impacts on the achievement of the Millennium Development Goals, and on human migration. For example, in Africa increased pressure on resources related to food and water insecurity can deepen tensions between communities and ethnic groups resulting in violence and war (Oxfam 2006, Sachs 2007).

As the incidence and magnitude of events such as droughts, floods and island inundation increase, there could be large-scale demographic responses, such as increased migration and threats to the sovereignty of some small island States. The United Nations University Institute for Environment and Human Security (UNU-EHS) reported in 2005 that there were at least 20 million “environmental refugees” worldwide, more than those displaced by war and political repression combined. UNU-EHS predicts that by 2010 the number of environmental refugees could grow to 50 million and, according to further estimates, there could be as many as 150 million by 2050 (Myers 2005).

Considering that the adverse effects of climate change pose an additional burden to development goals, integrating adaptation into sustainable development is necessary, and is already being considered and implemented by some developing countries, although it is still in its early stages. Sustainable development in the context of climate change is a particular challenge for SIDS, particularly as they have been among the first to experience the direct effects of climate change. The Mauritius Strategy for

the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States (Mauritius Strategy) outlines actions for the international community to help SIDS in addressing the threats posed by climate change. This includes actions for the development, transfer and dissemination of appropriate technologies and practices to address climate change; building and enhancing scientific and technological capabilities and enhancing the implementation of national, regional and international global atmospheric observing systems.

In the tourism sector, sustainable practices must be established, developed or promoted in synergy with adaptation activities and work to protect biodiversity. Links and synergy must also be encouraged between the programmes of work on biodiversity and climate change under the two Conventions, in particular with regard to island biodiversity. Although many developing countries have ratified the Conventions, support is still needed from their development partners to ensure effective implementation of their emerging strategies and plans, as well as to fully exploit the opportunities that could be achieved.

At the adaptation workshops and expert meeting, synergy between the UNFCCC and the other two Rio Conventions, the Convention on Biological Diversity, and the UN Convention to Combat Desertification, was highlighted as important for implementing adaptation projects, sharing data collection and information networking. This would help integrate the Conventions into national development programmes, a problem encountered by many countries at present, and help establish synergies and linkages among the Conventions.

The Stern Review highlighted that the costs of strong and urgent action on climate change will be less than the costs thereby avoided of the impacts of climate change under business as usual (Stern 2006). All countries, rich and poor, need to adapt to climate change and this will be costly. Developing countries, already the hardest hit by climate change, have little capacity (both in human capacity and financial resources) to adapt. Spending to adapt to climate change will undermine funding for sustainable development, putting strong pressure on developing country budgets and overseas development assistance. It is therefore vital that ways and means are found to enable developing countries to enhance their efforts to adapt in the context of sustainable development and sustainable development must incorporate adaptation plans.

**Table V-6. Impacts of Climate Change on the Millennium Development Goals**

Millennium Development Goal	Potential impacts of climate change
<b>Goal 1</b> Eradicate extreme poverty and hunger	<ul style="list-style-type: none"> <li>– Damage to livelihood assets, including homes, water supply, health, and infrastructure, can undermine peoples' ability to earn a living;</li> <li>– Reduction of crop yields affects food security;</li> <li>– Changes in natural systems and resources, infrastructure and labour productivity may reduce income opportunities and affect economic growth;</li> <li>– Social tensions over resource use can lead to conflict, destabilising lives and livelihoods and forcing communities to migrate.</li> </ul>
<b>Goal 2</b> Achieve universal primary education	<ul style="list-style-type: none"> <li>– Loss of livelihood assets and natural disasters reduce opportunities for full time education, more children (especially girls) are likely to be taken out of school to help fetch water, earn an income or care for ill family members;</li> <li>– Malnourishment and illness reduces school attendance and the ability of children to learn when they are in class;</li> <li>– Displacement and migration can reduce access to education.</li> </ul>
<b>Goal 3</b> Promote gender equality and empower women	<ul style="list-style-type: none"> <li>– Exacerbation of gender inequality as women depend more on the natural environment for their livelihoods, including agricultural production. This may lead to increasingly poor health and less time to engage in decision making and earning additional income;</li> <li>– Women and girls are typically the ones to care for the home and fetch water, fodder, firewood, and often food. During times of climate stress, they must cope with fewer resources and a greater workload;</li> <li>– Female headed households with few assets are particularly affected by climate related disasters.</li> </ul>
<b>Goal 4</b> Reduce child mortality	<ul style="list-style-type: none"> <li>– Deaths and illness due to heat-waves, floods, droughts and hurricanes;</li> <li>– Children and pregnant women are particularly susceptible to vector-borne diseases (e.g. malaria and dengue fever) and water-borne diseases (e.g. cholera and dysentery) which may increase and/or spread to new areas – e.g. anaemia resulting from malaria is currently responsible for one quarter of maternal mortality;</li> </ul>
<b>Goal 5</b> Improve Maternal Health	<ul style="list-style-type: none"> <li>– Reduction in the quality and quantity of drinking water exacerbates malnutrition especially among children;</li> <li>– Natural disasters affect food security leading to increased malnutrition and famine, particularly in sub-Saharan Africa.</li> </ul>
<b>Goal 6</b> Combat HIV/AIDS, malaria and other diseases	<ul style="list-style-type: none"> <li>– Water stress and warmer conditions encourage disease;</li> <li>– Households affected by AIDS have lower livelihood assets, and malnutrition accelerates the negative effects of the disease.</li> </ul>
<b>Goal 7</b> Ensure environmental sustainability	<ul style="list-style-type: none"> <li>– Alterations and possible irreversible damage in the quality and productivity of ecosystems and natural resources;</li> <li>– Decrease in biodiversity and worsening of existing environmental degradation;</li> <li>– Alterations in ecosystem-human interfaces and interactions lead to loss of biodiversity and loss of basic support systems for the livelihood of many people, particularly in Africa.</li> </ul>
<b>Goal 8</b> Develop a global partnership for development	<ul style="list-style-type: none"> <li>– Climate change is a global issue and a global challenge: responses require global cooperation, especially to help developing countries adapt to the adverse effects of climate change;</li> <li>– International relations may be strained by climate impacts.</li> </ul>

Source: Source: National communications of non-Annex I Parties and UNFCCC Sixth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention. Note by the secretariat. Addendum 5. Climate change impacts, adaptation measures and response strategies

There is a need to develop integrated, well planned and coordinated adaptation actions and adaptation projects, and to improve financial flows into adaptation-related activities through existing and new international, official development assistance and private sector mechanisms thus providing a firm basis for sustainable development.

## 5.6 ADAPTATION INTEGRATION INTO POLICY AND PLANNING

Incorporating or integrating adaptation to climate change into planning processes is a necessary strategy for sustainable development over the long term. Climate change impacts do not happen in isolation; impacts in one sector can adversely or positively affect another; sectors can be affected directly and/or indirectly by climate change and indeed sometimes a change in one sector can offset the effects of climate change in another sector. In many developing countries there are difficulties in integrating adaptation concerns into national policy due to low staff capacity for planning, monitoring and evaluation; poor data on adaptation options and lack of mechanisms for information sharing and management across sectors; and limited awareness of adaptation among stakeholders and the population. The Africa workshop identified several further factors that exacerbate the overall level of vulnerability in this region including political instability, widespread illiteracy and poverty of the rural population.

Lack of cooperation among ministries was highlighted as a major barrier to progress on adaptation. In order that real progress can be made, key governmental departments (such as ministries of finance) need to be involved in the development of adaptation strategies. In the same way, national and local development planning agencies need to be informed by the relevant outputs of impact and vulnerability assessments, and environmental and sectoral institutions need to be strengthened in order to be able to address the complexities of addressing and coordinating the implementation of adaptation action. There are a number of actions that can help facilitate adaptation and integration of adaptation into policy, including actions at the local level (e.g. strengthening coping strategies and feedback to national policies), the national level (e.g. inter-agency coordination in the water sector and legal provisions for mainstreaming) and the regional level (e.g. incorporating climate change risks in projects of regional development agencies and the creation of intersectoral committees to be engaged in the formulation of adaptation plans). At the international level it was

noted that the UNFCCC, other Conventions and other international organizations can play a catalytic role in exchange of experiences, and in facilitating the development of region-wide and sector-wide approaches.

Policy and development planners require effective tools and frameworks for developing, disseminating and building capacity for adaptation and integrating it into policy at all levels (e.g. UNDP 2004). This is a particular priority for SIDS for whom international relocation is not an option. In addition to the socio-economic consequences, relocation would mean an infringement on the sovereignty of these islands. Participants at the workshops and meeting highlighted the importance of building on existing collaboration frameworks such as those of the Congo Basin Forest Partnership (CBFP), the Forum of Ministers of Environment of Latin America and the Caribbean, the Economic Commission for Latin America and the Caribbean (ECLAC), the Organization of Eastern Caribbean States (OECS), the Caribbean Community Climate Change Centre (CCCCC), the Pacific Islands Forum (PIF), the Secretariat of the Pacific Community (SPC), and the Pacific Regional Environment Programme (SPREP). Small island developing States were among the first to start work on integrating adaptation. Some examples of integrating adaptation into research, policy and development in SIDS are given in [Box V-5](#).

As climate change increases the potential for climate related risk, it is also important that risk management and risk reduction is incorporated into adaptation planning at all levels, and that climate change is incorporated into disaster and risk management activities. The ISDR secretariat has highlighted the necessity for integrating disaster reduction management into development and adaptation strategies. The Hyogo framework was adopted at the World Conference on Disaster Reduction in Kobe, Japan, in January 2005, and gives prominence to disaster risk reduction in the context of climate change. Considerations include promoting the integration of risk reduction associated with existing climate variability and future climate change into strategies for the reduction of disaster risk and adaptation to climate change; and mainstreaming disaster risk reduction measures appropriately into development assistance programmes, including those relating to, inter alia, adaptation to climate change. The ISDR secretariat is establishing national platforms on disaster risk reduction where participation of practitioners in the area of adaptation is highly encouraged. Meetings of these national platforms will be held annually at regional level to exchange information, experiences and lessons learned.

A number of examples of integrating adaptation and policy planning by institutions and governments were highlighted at the workshops and meeting. The Caribbean Development Bank was one of the first to integrate climate change into its project planning process. The Inter-American Development Bank<sup>40</sup> has a disaster risk management policy which was developed in the context of an increase in the number and gravity of natural hazards resulting in disasters in Latin America. The policy, which emphasizes risk reduction, is intended to improve the institutional and policy framework of the bank's support to disaster risk management in order to help protect the socio-economic development of member countries and improve the effectiveness of the bank's assistance. The Asian Development Bank (ADB) is increasingly integrating adaptation considerations into its strategic planning processes at the country level and taking measures to reconfigure sector development plans so that they are more resilient to climate change. More directly, they are organizing to provide greater support for national climate change adaptation planning and programming efforts.<sup>41</sup> On the other hand, the World Bank found a quarter of its

portfolio subject to climate risk but only two percent consider it in the project design documents (World Bank 2006b). The World Bank is now aiming to earmark specific funds and create new financial instruments for adaptation.

In April 2006 OECD Member Countries adopted the Declaration on Integrating Climate Change Adaptation into Development Cooperation.<sup>42</sup> They declare that they will aim to work to better integrate climate change adaptation in development planning and assistance, both within their own governments and in activities undertaken with partner countries. In addition they encourage regional initiatives that include common actions on impacts and vulnerability assessment and adaptation options, in order to promote transboundary initiatives, encourage

<sup>38</sup> The advisory body to the integrated agriculture and forestry programme being implemented by the Land Resources Division of the Secretariat of the Pacific Community.

<sup>39</sup> The Jamaica Observer, online article, posted 25 July 2006.

<sup>40</sup> <<http://www.iadb.org>>

<sup>41</sup> From the Asian Development Bank submission to the UNFCCC's Nairobi Work Programme "ADB's Clean Energy and Environment Program" <[http://unfccc.int/files/adaptation/sbsta\\_agenda\\_item\\_adaptation/application/pdf/adb\\_ccadaptation.pdf](http://unfccc.int/files/adaptation/sbsta_agenda_item_adaptation/application/pdf/adb_ccadaptation.pdf)>

<sup>42</sup> <<http://www.oecd.org/dataoecd/44/29/36426943.pdf>>

<sup>43</sup> <<http://www.aiaccproject.org/aiacc.html>>

#### Box V-5.

#### Integrating adaption activities into national planning

Some examples of cooperation on adaptation, and its integration into research, policy and development in SIDS

**Research:** In July 2006, the University of the West Indies held a conference entitled "Global Change and Caribbean Vulnerability: Environment, Economy and Society at Risk?" where researchers took a multi-disciplinary view of climate change in the Caribbean, linking changes in climate with other environmental and socio-economic changes that are occurring.

**Policy:** The Climate Change Adaptation Program for the Pacific, funded by the Asian Development Bank, has produced a set of guidelines on mainstreaming adaptation, focusing on its integration into disaster risk reduction strategies (ADB 2005).

**National and international meetings:** In 2006, the Regional Meeting of the Heads of Agriculture and Forestry<sup>38</sup> structured their discussions around the theme "Managing Change". Change was considered in the context of biodiversity, health and nutrition, agriculture and forestry commodity trade, atoll agriculture and forestry and climate change and food security.

**National partnerships:** In Jamaica, the Jamaican Red Cross is joining forces with the National Meteorological Service, the Office of Disaster Preparedness and Emergency Management and the University of the West Indies to disseminate information on climate change impacts and inform those communities that are most at risk.<sup>39</sup>

**International Partnerships:** Through the UNEP-Grid Arendal Many Strong Voices consortium, SIDS from both the Caribbean and Pacific regions are cooperating with Arctic communities to build capacity, enhance awareness, assess needs and implement adaptation measures. These regions, although geographically and climatically very different, share a high vulnerability to climate change because of their dependence on the natural resource base and geographical and socio-economic isolation. The consortium focuses on the links between the regions and on encouraging education, training and public awareness among their inhabitants so that they take a more active role in the climate change debate. It also aims to increase understanding of needs and solutions and take practical measures on adaptation.

South-South cooperation and avoid duplicated efforts. In 2003, the European Commission produced a communication entitled "Climate Change in the context of development co-operation", in which it proposed an EU action plan aimed at integrating climate change concerns into EU development cooperation activities. The World Bank's progress report on its investment framework for clean energy and development asserts that "it is essential that the Bank Group, along with other International Financial Institutions, play a leading role in ensuring that maximum impact is obtained from UNFCCC funds by mainstreaming appropriate investment and appropriate risk in the global development portfolio" (World Bank 2006b).

## 5.7 CAPACITY-BUILDING, EDUCATION AND TRAINING AND PUBLIC AWARENESS

Capacity-building at local, national and regional levels is vital to enable developing countries to adapt to climate change. It is important for stakeholders and funders to recognize the role of universities, tertiary centres and centres of excellence. Enhanced support is needed for institutional capacity-building, including establishing and strengthening centres of excellence and building up hydrometeorological networks. Training for stakeholders in all sectors would help the development of specialized tools for planning and implementing adaptation activities and thus promote action by local and national governments.

Participants at the workshops and expert meeting emphasized the need for capacity-building, training and increased public awareness as well as international support to build and strengthen environmental and sectoral institutions so that they can address the complexities of addressing and coordinating the planning and implementation of adaptation action. Internationally-coordinated capacity-building and training through the Convention and appropriate regional agencies was recognized as extremely important for advancing climate change adaptation in all regions. Support for institutional strengthening can be enhanced through multilateral and bilateral channels. For example, the Assessments of Impacts and Adaptations to Climate Change project, 2001 – 2006, involved enhancing the scientific and technical capacity among researchers within developing countries to help understand climate change adaptation and vulnerability.<sup>43</sup>

### 5.7.1 CAPACITY-BUILDING

The need for capacity-building to assist Parties, especially developing countries, to respond to climate change has long been recognized by the UNFCCC. Work in this area by the Convention includes the elaboration of the capacity-building frameworks under decisions 2/CP.7<sup>44</sup> and 3/CP.7<sup>45</sup>, providing guidance on national communications and NAPA preparation, and capacity-building for adaptation research under the Nairobi work programme.

Governments, national and international agencies also provide capacity-building for adaptation. These include other United Nations organizations, for example the UNEP funded Caribbean Environment Programme<sup>46</sup>, represented at the SIDS meeting, promotes regional cooperation for the protection and development of the marine environment of the Wider Caribbean Region. At the Africa workshop, the World Conservation Union (IUCN) detailed their work on capacity-building for adaptation including their Community-based Risk Screening Tool-Adaptation and Livelihoods (CRISTAL). This tool can reduce impacts of climate change on community livelihoods. It was first tested in an IUCN project in Mali (Inner Delta of the Niger River) and is to be made widely available after further tests (e.g. in Tanzania).

Non-governmental agencies and organizations involved in capacity-building for adaptation include the Red Cross/Red Crescent Centre of Climate Change and Disaster Preparedness<sup>47</sup> and SouthSouthNorth<sup>48</sup> – a network of organizations, research institutions and consultants operating in Brazil, South Africa, Tanzania, Mozambique, Bangladesh and Indonesia whose projects are aimed at driving the sustainable development agenda and building capacity for adaptation to climate change at the local level.

Some developing countries have already included adaptation measures in their national action plans and/or national environmental action plans as a first step towards implementation of adaptation. For example the NAPAs of least developed countries have helped build capacity for adaptation at the local and community level by building on and enhancing existing coping strategies. Expanding the NAPA process to other developing countries has been proposed to help these countries also build capacity for adaptation planning and implementation.

Representatives at the workshops and expert meetings reported that some legislative changes and recognition by all government ministries would help facilitate incorporation of climate change adaptation into future policy. It was

suggested that intersectoral committees can help in integrating adaptation into policy. Examples of these include the Caribbean Planning for Adaptation to Climate Change project, which developed climate change scenarios for the Caribbean and calculated potential losses. Following on from this project, a comprehensive adaptation programme is now underway in the Caribbean which includes the Mainstreaming Adaptation to Climate Change project bringing together climate change and disaster management communities, and the Special Program on Adaptation to Climate Change.

One of the challenges for capacity-building mentioned at the workshops is that external support of adaptation activities, including developing national communications, are short-term and project-based, often using a single task approach rather than a long-term programme approach. This means that expertise is lost between projects, and often it is difficult to retain experts once they reach a high level of expertise. Working groups created under projects, that show significant potential for providing technical and scientific support need to realize their potential by disseminating information better and building up best practices. For example, the Linking Climate Adaptation (LCA) Network was set up to help communities, policy-makers, practitioners and academics share experiences and knowledge about adaptation to climate change.<sup>49</sup>

#### 5.7.2 EDUCATION AND TRAINING

Education and training of stakeholders, including policy-level decision makers, are important catalysts for the success of assessing vulnerabilities and planning adaptation activities, as well as implementing adaptation plans. It is important to communicate both successful and unsuccessful efforts at planning and implementation to avoid future mistakes. Short policy cycles are a major challenge in keeping decision makers up to date.

Effective training and capacity-building needs support and funding, often from external agencies and donors. Within the UNFCCC, regional teams have helped deliver training, such as in the case of the Least Developed Countries Expert Group which provides advice to least developed countries on the preparation and implementation of national adaptation programmes of action, and the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention which has conducted hands-on training workshops for the Africa region, the Asia and the Pacific region, and the Latin America and the Caribbean region (FCCC/SBI/ 2006/ 17, UNFCCC 2006g) and for SIDS(FCCC/SBI/2007/17, UNFCCC 2007j).

Training is also needed for models to be effectively applied and used for assessments at the national or regional level. For example the PRECIS initiative helps build capacity by training on how to use the climate model to generate high resolution climate change scenarios for developing countries.<sup>50</sup>

Collaboration between educational, training and research institutions would help to enable the formal exchange of experience and lessons learned among different institutions of the respective regions. Universities, tertiary centres and research centres have a special role to play in educating and building the capacity of stakeholders in key sectors, and climate change and adaptation issues should be integrated into education curricula. For example the Global Change SysTEm for Analysis, Research and Training (START) fosters regional networks of collaborating scientists and institutions and provides a wide variety of training and career development opportunities for young scientists. The START regional networks in Southeast Asia, South Asia, East Asia, SIDS and Africa help to mobilize scientific capacity and resources to address region specific issues of global change and to assist in creating working links between science and policy communities.

Effective international collaboration also helps to enable training on, and structured dissemination of, international and national activities on adaptation with a view to retaining experts working in their region, and promoting the exchange of information between experts from key sensitive sectors. It is also important to assess, systematize and disseminate knowledge about adaptation measures taken, including indigenous ones. The UNFCCC database on local coping strategies is one example of this effort as well as the workshops organised under the Nairobi work programme.

<sup>43</sup> <<http://www.aiaccproject.org/aiacc.html>>

<sup>44</sup> <<http://unfccc.int/resource/docs/cop7/13a01.pdf#page=5>>

<sup>45</sup> <<http://unfccc.int/resource/docs/cop7/13a01.pdf#page=15>>

<sup>46</sup> <<http://www.unep.org/regionalseas>>

<sup>47</sup> <<http://www.climatecentre.org>>

<sup>48</sup> <<http://www.southsouthnorth.org>>

<sup>49</sup> <<http://www.linkingclimateadaptation.org>>

<sup>50</sup> <<http://precis.metoffice.com>>

It is important to recognise the language needs of particular regions. Often, the tools and material available to experts on adaptation planning and implementation is mainly in English. For Africa, the availability of technical documentation in French and possibly African languages needs to be enhanced for experts in the region to fully participate in the adaptation process. In Latin America, there is a need for the documentation to be available in Spanish.

### 5.7.3 PUBLIC AWARENESS

Participants at the workshops and meeting noted that awareness on climate change risks and the need for adaptation should be raised among key sectors and mass media, including by using current events, such as economic, weather and health crises, as a basis to promote adaptation measures with co-benefits. Improving public awareness and developing overall communications strategies makes climate change science accessible to the average citizen and can reduce their vulnerability. Besides awareness-raising at local levels, it is also important to involve high-level policymakers to ensure integration of climate change risks into national development policies. For example, in Cuba, hurricane and disaster risk reduction is taught in schools and training is carried out for the entire population every year (Cuba 2001). Important public awareness activities include linking research to policy-making, with an emphasis on getting research messages to appropriate target groups and building credibility of forecasts and improving their dissemination and use.

A communication strategy is an effective way of elaborating and communicating between knowledge providers and stakeholders on climate change risks and adaptation needs, targeting actors ranging from those at the grassroots level to national and regional policymakers, using appropriate language. This communication strategy could include the preparation of a global awareness campaign on climate change, including video messages in different languages.

## 5.8 COOPERATION AND SYNERGIES

Given that many countries may experience similar effects from climate change, sharing experience can broaden knowledge on how to address the adaptation challenges. In this regard South-South and North-South cooperation on adaptation is an effective tool for promoting the implementation of adaptation measures. There is still considerable scope and opportunity for regional and international collaboration.

The workshops and meeting highlighted the need for all stakeholders including governments, institutions and the private sector in the North and South to be fully engaged in adaptation planning and implementation. Climate change should be integrated into the work of different regional organizations and networks, and in particular through partnerships of sectors such as water and agriculture in order to share experiences and lessons learned by communities facing similar problems. New funding and improved access to funding, including through existing GEF funds, is needed to effectively provide technical and financial support and capacity-building capabilities.

Existing mechanisms for regional (South-South) cooperation on vulnerability assessment and adaptation include forums of ministers, economic commissions, bilateral cooperation initiatives and initiatives to share information and data. Collaboration between Southern institutions helps to share experiences and lessons learned by communities facing similar problems; develop joint projects; carry out research and development on downscaling of climate scenarios; and conduct workshops and training activities.

The regional workshops and expert meeting emphasized a need to enhance coordination of activities between different organizations, networks and initiatives to promote South-South collaboration. Inadequate capacity and resources, including such fundamental problems as poor communication and transport infrastructure, were seen as hindrances to such collaboration. Fostering cooperation among researchers and institutions also lays a good foundation. Additional regional workshops focusing on specific areas of priority for different regions were suggested in order to enhance such exchange of experience by the groups already working on collaboration in the regions.

The activities considered most effective for regional collaboration identified at the workshops were projects helping to identify common problems and solutions such as developing national climate change scenarios, solving transboundary adaptation issues such as with water resources, and developing 'sister' projects between countries facing similar challenges. Example projects include the GEF-funded project to design and implement adaptation measures to address glacial melt in the central Andes, and the Pacific Island Adaptation Initiative designed to catalyze action and strengthen partnerships at all levels to enable the Pacific Island's region to understand and respond to climate change, climate variability and sea level rise.

Mechanisms for current international (North – South) collaboration involve a wide-range of initiatives and funding by inter-governmental agencies, governments, institutions and non-government agencies. Collaboration includes the assessment of vulnerability and risks associated with climate change such as funding for national communications and NAPAs, public education and outreach, data and observations, decision support, adaptation planning and implementation, and integration of climate change into development.

Participants at the workshops and meeting proposed a number of options to further facilitate North-South cooperation. Promoting better access to funding and synergy with sources of funding external to the climate change process is vital and has been referred to in the previous section on funding. Effective collaboration with government and non-government organizations, including through global fora on adaptation, would improve stakeholder awareness to enable adaptation on a sustainable and long term basis. Integrating climate change considerations in the work of regional and international financial bodies and organizations would also provide a basis for work in the long term. It is important to engage fully the private sector from the North and South in adaptation planning and implementation on a sectoral basis and use a programme based, rather than a project based approach to adaptation, to ensure a long-term and sustainable approach to adaptation.

The UNFCCC process needs to play a more active role in enhancing North – South collaboration, as well as in disseminating information and enhancing the dialogue on climate change adaptation with other United Nations agencies, and the sectoral and disaster reduction communities, attempts to do so include through the Nairobi work programme. Synergy with other multilateral

environment agreements in future adaptation activities and projects is paramount for advancing collaboration. There is a critical need to ensure continuity (a programme-based rather than project-based approach) and adherence to the strategic direction for support identified by the COP, in particular by its decisions 5/CP.7<sup>51</sup> and 1/CP.10,<sup>52</sup> and, in the case of SIDS, the Mauritius Strategy.

North – South collaboration could also be instrumental in facilitating South–South collaboration, for example the Ibero-American Network of Climate Change Offices (RIOCC). This network, created as a result of a decision taken by Ministers at the IV Ibero-American Ministers of Environment Forum in 2004, is now active in the 21 Ibero-American Nations. Its work programme focusses on different topics related to climate change, including adaptation.<sup>53</sup> The UNEP – UNDP partnership for mainstreaming climate change was established during the twelfth session of the COP, and is working on operational issues for adaptation and its integration into national planning for sustainable development.

## 5.9 IMPLEMENTING ADAPTATION

Implementing adaptation plans and strategies is a vital next step for developing countries. As highlighted in this chapter, many plans and strategies have been made and a number of capacity-building projects have been undertaken. Now, it is important to bridge the gap between adaption assessment and planning and adaption implementation, and to build on knowledge from capacity-building projects. Adaptation options need to be matched to priority needs both in the context of community-based action and in national and sectoral planning as well as disaster risk reduction. Adaptation plans must be integrated into top-down and bottom-up approaches for planning to enable sustainable development and the efficient use of resources for adaptation. In order to avoid maladaptation, mechanisms should be introduced to validate adaptation options. Participants from developing countries at the workshops and meeting discussed and suggested a number of ways forward to help implement adaptation in developing countries.

<sup>51</sup> <<http://unfccc.int/resource/docs/cop7/13a01.pdf#page=32>>

<sup>52</sup> <<http://unfccc.int/resource/docs/cop10/10a01.pdf#page=2>>

<sup>53</sup> <[http://www.mma.es/portal/secciones/cambio\\_climatico/areas\\_tematicas/cooperacion\\_cc/menu\\_coop\\_iber.htm](http://www.mma.es/portal/secciones/cambio_climatico/areas_tematicas/cooperacion_cc/menu_coop_iber.htm)>

Implementing identified adaptation projects including those proposed through the NAPA process would be an important start for developing countries. Given the good experience so far identified with NAPAs, the methodology could be extended to other developing countries beyond the least developed. Expanding knowledge on local coping strategies would also help implement community based action on adaptation, for example through enhancing the UNFCCC's local coping strategies database.

National governments were identified as having the responsibility to scale up lessons learned and products from adaptation projects for use nationally. In order to do so, creating awareness on adaptation among planners and political decision makers beyond the environment sectors, and training of stakeholders within these areas, is a useful start. Operational guidelines could be prepared to help integrate adaptation into various sectors from national to local level and from local to national level, and to encourage countries in the regions to implement more pilot projects and facilitate funding for such projects.

It is clear that enhanced funding is required for adaptation projects in developing countries and needs to be increased in national budgets as well as in multilateral funds. All regions requested improvements in the access to the financial resources currently available, including through streamlining guidelines for application, and by assisting countries in the preparation of project proposals. Novel mechanisms for funding could include adaptation funds designed for specific regions as well as a variety of insurance options including those which include public-private and sectoral partnerships.

Capacity must be built at all stages of the adaptation process in developing countries. Climate change focal points could be trained. Inventories of successful experiences and expertise available could be developed. Links with the disaster risk reduction community, especially with regard to disaster preparedness rather than relief, could be reinforced. Enhancing synergies between the Rio Conventions would help share information and knowledge on assessment processes. Capacity-building and training of stakeholders would help the necessary integration of adaptation into sectoral policies and environmental impact assessments. International climate change committees could be created to help feed relevant information into regional committees. Collaboration among institutions active on climate change in all developing country regions and with institutions in the North would help knowledge exchange and build capacity. National forums could help exchange information on vulnerability assessments, and adaptation planning and implementation at regional level.



## VI. LOOKING FORWARD

Developing countries are already suffering from the impacts of climate change and are the most vulnerable to future change. A number of developing countries have developed adaptation plans or are in the process of finalizing them. This includes the National Adaptation Programmes of Action of least developed countries. There is now an urgency for developing countries to find ways to implement these plans. Against a backdrop of low human and financial capacity, developing countries lack many of the resources to do this on their own.

Adaptation is already considered a vital part of any future climate change regime. Within the UNFCCC and the international community, deliberations are building to find an effective means to tackle climate change, which is described by UN Secretary General Ban Ki-moon as the "defining issue of our era". Future decisions within the UNFCCC negotiating process must assist developing countries in a streamlined, innovative and transparent way, with transfer of knowledge, technology and financial resources to adapt and to adapt at all levels and in all sectors.

At a series of workshops for Africa, Asia and Latin America and an expert meeting for small island developing States during 2006–2007, these regions identified areas for future action in adapting to climate change. To be most effective, adaptation plans and strategies need to be integrated into sustainable development planning and risk reduction planning at community, local, national and international levels. Crucially there has been little work to integrate adaptation into development plans or within existing poverty alleviation frameworks. Taking stock of and promoting good practice by the international community in the integration of climate change related issues would help promote adaptation strategies with multiple benefits.

Capacity is still needed to enable developing countries to develop adaptation programmes and strategies. The Nairobi work programme is building capacity to understand and assess impacts, vulnerability and adaptation and to make informed decisions on practical adaptation actions and measures. The NAPAs have proved an important way to prioritise adaptation actions for least developed

countries. Initiating a process for extending the positive experience of NAPAs for developing countries that are not least developed countries, and that wish to develop national adaptation programmes or strategies, could vitally help adaptation option prioritisation. This would take into account lessons learned from the NAPA preparation process and its successful experience at policy integration, as well as relevant outcomes from the Nairobi work programme. Using local coping strategies can assist community-based adaptation and can be facilitated by knowledge exchange within different communities facing similar problems, such as via the UNFCCC local coping strategies database. Finding synergies between the Rio Conventions could also help share information and knowledge on assessment processes.

If there are delays to implementing adaptation in developing countries, including delays in financing adaptation projects, this will lead ultimately to increased costs. Delays in implementing adaptation will also lead to greater dangers to more people. For example, extreme events including droughts, floods and loss of glacial meltwater could trigger large-scale population movements and large-scale conflict due to competition over scarcer resources such as water, food and energy.

There are already mechanisms for financial assistance for developing countries available. Application procedures need to be streamlined, including enhancing the capacity for the development of project proposals as well as capacity-building to identify the different requirements and modalities of different sources of current support.

It is also clear that current funding is not enough to support adaptation needs. Recent studies by the UNFCCC secretariat showed that an incremental level of annual investment and financial flows of about USD 50 billion is needed for adaptation in 2030. In the context of any discussion on future international cooperation on climate change, future financial resources need to be sufficient, predictable and sustainable in order to facilitate adaptation to the adverse impacts of climate change by developing countries. As well as via funding envisioned through the operationalization of the Adaptation Fund under the Kyoto Protocol, innovative financing options are needed to close the gap between costs of adaptation and available resources.

Insurance is an area that has been identified as an important component of future action on adaptation. Innovative risk sharing mechanisms are needed to respond to the new challenges posed, including increasing frequency of extreme events, land degradation and loss of biodiversity.

Collaboration and cooperation between South-South and North-South can directly engage multiple stakeholders in dealing with climate change and coordinate planning and actions. This could be facilitated by international fora with the participation of Parties and relevant stakeholders involved in South-South and North-South collaboration, multilateral environmental agreements and with the disaster risk reduction community. Awareness raising among the key sectors and mass media, including using current events such as economic, weather and health crisis can also help promote adaptation measures with co-benefits.

Climate change requires a global framework for international cooperation. Adaptation action is a vital part of this framework. Actions to enable adaptation to climate change pose opportunities to promote sustainable development. Developing countries require resources in order to promote these actions. A successful framework must directly involve assistance for adaptation in developing countries, particularly small island developing States and least developed countries, given that they will disproportionately bear the brunt of climate change impacts.



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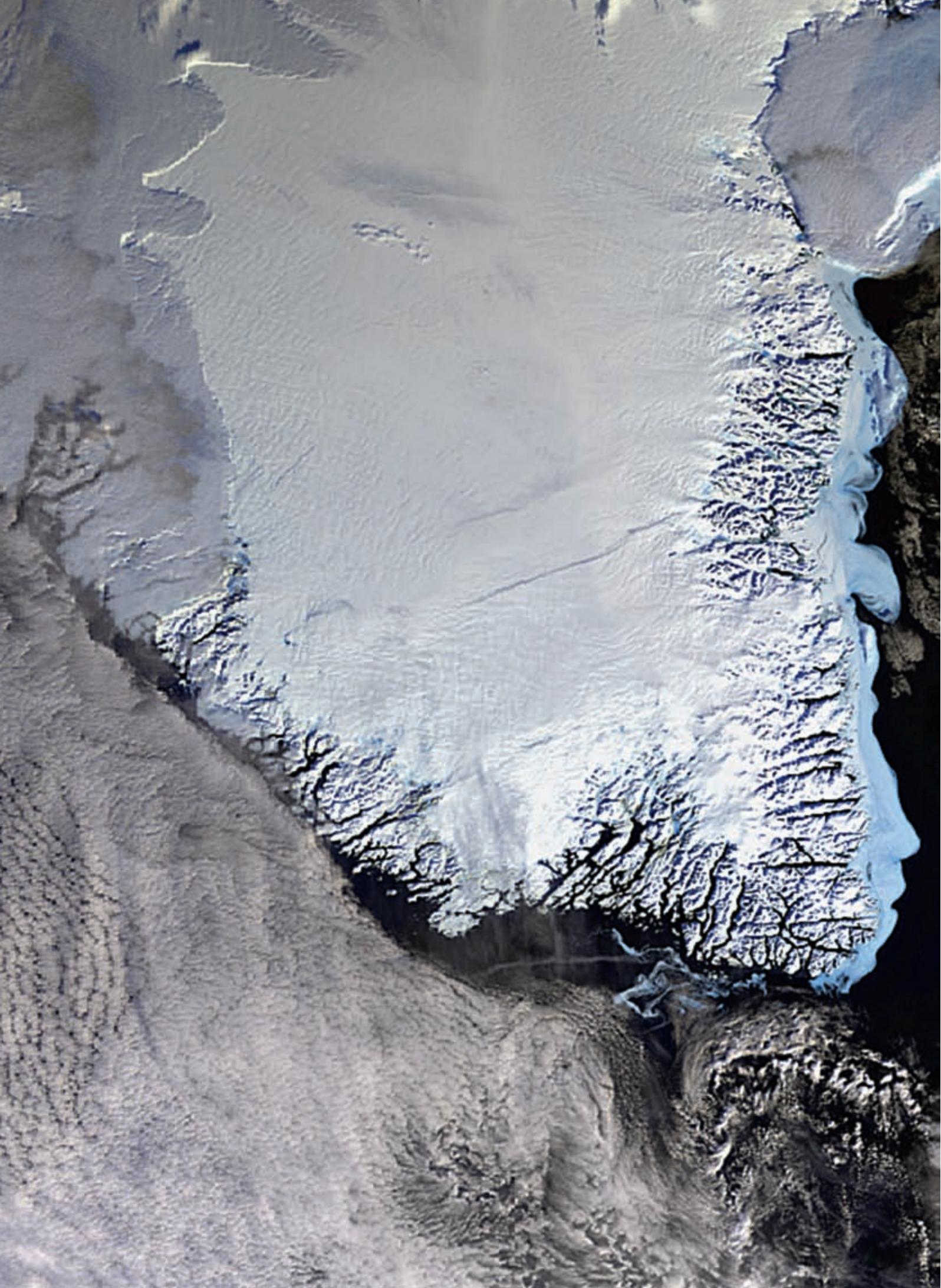
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## ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AIACC	Assessments of Impacts and Adaptations to Climate Change in Multiple Regions and Sectors
CBA	Community based adaptation
CBA-X	Community based adaptation exchange
CCCCC	Caribbean Community Climate Change Centre
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CH <sub>4</sub>	methane
CO <sub>2</sub>	carbon dioxide
CRISTAL	Community-based Risk Screening Tool-Adaptation and Livelihoods
ECLAC	Economic Commission for Latin America and the Caribbean
ENSO	El Niño Southern Oscillation
FAO	Food and Agriculture Organization
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GTZ	German Agency for Technical Cooperation
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
ISDR	International Strategy for Disaster Reduction
IUCN	World Conservation Union
LCA	Linking Climate Adaptation
LDC	Least Developed Country
LDCF	Least Developed Countries Fund
MACC	Mainstreaming Adaptation to Climate Change
Mauritius Strategy	Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States
MEA	multilateral environmental agreement
Nairobi work programme	Nairobi work programme on impacts, vulnerability and adaptation to climate change
N <sub>2</sub> O	nitrogen dioxide
NAPA	National adaptation programme of action
PACCLIM	PACific CLimate Impacts Model
PIF	Pacific Islands Forum
PRECIS	Providing REgional CLimates for Impacts Studies Model
OECS	Organization of Eastern Caribbean States
OSS	Sahara and Sahel Observatory
RIOCC	Ibero-American Network of Climate Change Offices
SCCF	Special Climate Change Fund
SIDS	Small island developing States
SGP	Small Grants Programme
SPA	Strategic Priority on Adaptation
SPC	Secretariat of the Pacific Community
SPREP	Pacific Regional Environment Programme
START	SysTem for Analysis, Research and Training
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP FI	United Nations Environment Programme Finance Initiative
UNFCCC	United Nations Framework Convention on Climate Change
UNU-EHS	United Nations University Institute for Environment and Human Security







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United Nations Framework Convention on Climate Change

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# **CLIMATE CHANGE:**

# **IMPACTS, VULNERABILITIES AND ADAPTATION IN DEVELOPING COUNTRIES**



United Nations Framework Convention on Climate Change