

# Climate Change and Disaster Risk Reduction

Geneva, September 2008

Climate change and disaster risk reduction are closely linked. More extreme weather events in future are likely to increase the number and scale of disasters, while at the same time, the existing methods and tools of disaster risk reduction provide powerful capacities for adaptation to climate change. This Briefing Note, prepared by the secretariat of the United Nations International Strategy for Disaster Reduction Secretariat (UNISDR), outlines the nature and significance of climate change for disaster risk, as well as the main perspectives and approaches of disaster risk reduction and how they can support adaptation strategies. It is aimed at experts and practitioners as well as non-specialists such as teachers and students, journalists and the interested public.



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## Weather, climate and climate change

### Defining climate change

For most people, the expression “climate change” means the alteration of the world’s climate that we humans are causing, through fossil fuel burning, clearing forests and other practices that increase the concentration of greenhouse gases (GHG)<sup>1</sup> in the atmosphere. This is in line with the official definition by the United Nations Framework Convention on Climate Change (UNFCCC) that climate change is the change that can be attributed “*directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*”.<sup>2</sup>

However, scientists often use the term for any change in the climate, whether arising naturally or from human causes. In particular, the Intergovernmental Panel on Climate Change (IPCC) defines “climate change” as “*a change in the state of the climate that can be identified ... by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer*”.<sup>3</sup> Each of these two definitions is relevant and important to keep in mind.

1 Greenhouse gases (GHGs) “are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth’s surface, the atmosphere itself, and by clouds.” The primary greenhouse gases include H<sub>2</sub>O, CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub> and O<sub>3</sub>. IPCC Fourth Assessment Report, Working Group I, Glossary of Terms: [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_Annexes.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Annexes.pdf).

2 UNFCCC Article 1, Definitions: [http://unfccc.int/essential\\_background/convention/background/items/1349.php](http://unfccc.int/essential_background/convention/background/items/1349.php).

3 IPCC Fourth Assessment Report, Working Group I, Glossary of Terms: [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_Annexes.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Annexes.pdf).

## Weather and climate

Weather is the set of meteorological conditions – wind, rain, snow, sunshine, temperature, etc. – at a particular time and place.

By contrast, the term “climate” describes the overall long-term characteristics of the weather experienced at a place. For example, Singapore, in the tropics, has a hot wet climate, while continental Mongolia always has cold winters. The ecosystems, agriculture, livelihoods and settlements of a region are very dependent on its climate.

The climate therefore can be thought of as a long-term summary of weather conditions, taking account of the *average conditions* as well as the *variability of these conditions*. The fluctuations that occur from year to year, and the statistics of extreme conditions such as severe storms or unusually hot seasons, are part of the climatic variability. Some slowly changing climatic phenomena can last for whole seasons or even years; the best known of these is the El Niño phenomenon.<sup>4</sup>

Since the atmosphere connects all weather systems and all climates, it is sometimes useful to describe the atmosphere, oceans and Earth surface as the “global climate system”.<sup>5</sup> Because the climate system is in a constant state of flux and has always exhibited natural fluctuations and extreme conditions, it is not possible to argue that any single extreme event is attributable to climate change. Only after a sufficient period and with hundreds of extreme events recorded can scientists determine if a specific event is within normal historical variation or is due to some other cause such as climate change.

4 IPCC Fourth Assessment Report, Working Group I, Glossary of Terms: [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_Annexes.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Annexes.pdf).

5 The “climate system” is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the land surface and the biosphere, and the interactions between them. IPCC Fourth Assessment Report, Working Group I, Glossary of Terms: [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_Annexes.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Annexes.pdf).

## What causes climate change

The Earth’s climate has varied considerably in the past, as shown by the geological evidence of ice ages and sea-level changes, and by the records of human history over many hundreds of years. The causes of past changes are not always clear but are generally known to be related to changes in ocean currents, solar activity, volcanic eruptions and other natural factors.<sup>6</sup>

The difference now is that global temperatures have risen unusually rapidly over the last few decades. There is strong evidence of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising average global sea levels. The IPCC Fourth Assessment Report concludes that the global warming is unequivocal. Atmosphere and ocean temperatures are higher than they have been at any other time during at least the past five centuries, and probably for more than a millennium.<sup>7</sup>

Scientists have long known that the atmosphere’s greenhouse gases act as a “blanket” which traps incoming solar energy and keeps the Earth’s surface warmer than it otherwise would be, and that an increase in atmospheric greenhouse gases would lead to additional warming. The current concentration of greenhouse gases in the atmosphere is now the highest it has been for the past 500,000 years, having grown by 70% between 1970 and 2004 alone, and having reached this level exceptionally quickly.<sup>8</sup> While there has been some controversy in the past, it is now widely accepted that human activities, in particular fossil fuel use and changing land-uses, are the dominant factor in this growth and are responsible for most of the warming observed over the past 50 years.<sup>9</sup>

6 IPCC Fourth Assessment Report, Working Group II, Technical Summary: [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_TS.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_TS.pdf).

7 IPCC Fourth Assessment Synthesis Report: [http://195.70.10.65/pdf/assessment-report/ar4/syr/ar4\\_syr.pdf](http://195.70.10.65/pdf/assessment-report/ar4/syr/ar4_syr.pdf).

8 IPCC Fourth Assessment Synthesis Report: [http://195.70.10.65/pdf/assessment-report/ar4/syr/ar4\\_syr.pdf](http://195.70.10.65/pdf/assessment-report/ar4/syr/ar4_syr.pdf).

9 IPCC Fourth Assessment Report, Working Group I, Frequently Asked Questions: [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_FAQs.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_FAQs.pdf).

## What does the future hold?

### Main projections for climate change

The projections of future climate patterns are largely based on computer-based models of the climate system that incorporate the important factors and processes of the atmosphere and the oceans, including the expected growth in greenhouse gases from socio-economic scenarios for the coming decades. The IPCC has examined the published results from many different models and on the basis of the evidence has estimated that by 2100:<sup>10</sup>

- The global average surface warming (surface air temperature change), will increase by 1.1 - 6.4 °C.
- The sea level will rise between 18 and 59 cm.
- The oceans will become more acidic.
- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent.
- It is very likely that there will be more precipitation at higher latitudes and it is likely that there will be less precipitation in most subtropical land areas.
- It is likely that tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures.

### How climate change will affect key sectors

The IPCC Fourth Assessment Report of the Working Group II “Impacts, Adaptation and Vulnerability”<sup>11</sup> describes the likely effects of climate change, including from increases in extreme events. The effects on key sectors, in the absence of countermeasures, may be summarized as follows.

**Water:** Drought-affected areas will likely become more widely distributed. Heavier precipitation events are very likely to increase in frequency leading to higher flood risks. By mid-century, water availability will likely decrease in mid-latitudes, in the dry tropics and in other regions supplied by melt water from mountain ranges. More than one sixth of the world’s population is currently dependent on melt water from mountain ranges.

**Food:** While some mid-latitude and high-latitude areas will initially benefit from higher agricultural production, for many others at lower latitudes, especially in seasonally dry and tropical regions, the increases in temperature and the frequency of droughts and floods are likely to affect crop production negatively, which could increase the number of people at risk from hunger and increased levels of displacement and migration.

**Industry, settlement and society:** The most vulnerable industries, settlements and societies are generally those located in coastal areas and river flood plains, and those whose economies are closely linked with climate-sensitive resources. This applies particularly to locations already prone to extreme weather events, and especially areas undergoing rapid urbanization. Where extreme weather events become more intense or more frequent, the economic and social costs of those events will increase.

**Health:** The projected changes in climate are likely to alter the health status of millions of people, including through increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts. Increased malnutrition, diarrhoeal disease and malaria in some areas will increase vulnerability to extreme public health and development goals will be threatened by longer-term damage to health systems from disasters.

### How climate change will affect the different regions of the world

Climate change will affect all countries, but people in the poorest countries and poor people in richer countries are more likely to suffer the most. They tend to live in high-

<sup>10</sup> IPCC Fourth Assessment Report, Working Group I, Summary for Policymakers: <http://195.70.10.65/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf>.

<sup>11</sup> IPCC Fourth Assessment Report, Working Group II Report: <http://195.70.10.65/ipccreports/ar4-wg2.htm>.

risk areas such as unstable slopes and flood plains, and often cannot afford well-built houses. Many of them depend on climate-sensitive sectors, such as agriculture, and have little or no means to cope with climate change, for example owing to low savings, no property insurance and poor access to public services. Climate change is expected to reduce already low incomes and increase illness and death rates in many developing countries. Africa, small island states, and the Asian and African mega-deltas are likely to be particularly affected by climate change. According to the IPCC:<sup>12</sup>

*Africa* is particularly vulnerable to the effects of climate change because of multiple stresses and low adaptive capacities, arising from endemic poverty, weak institutions, and complex disasters and associated conflicts. Drought will continue to be a primary concern for many African populations. The frequency of weather- and climate-related disasters has increased since the 1970s, and the Sahel and Southern Africa have become drier during the twentieth century. Water supplies and agricultural production will become even more severely diminished. By 2020, in some African countries agricultural yields could be reduced by as much as 50%. By the 2080s, the area of arid and semi-arid land in Africa will likely increase by 5-8%.

*Asia's* sustainable development will be challenged as climate change compounds the pressures that rapid urbanization, industrialization, and economic development have placed on natural resources. One of the main issues will be the availability of adequate fresh water, which by the 2050s will be a concern for possibly more than one billion people. The continued melting of glaciers in the Himalayan region is projected to increase flooding and rock avalanches and to adversely affect water resources in the next two to three decades. Asia's coastal areas, and especially its heavily populated delta regions, will become even more prone to increased flooding because of both rising sea levels and river flooding.

*Australia and New Zealand* may face more frequent extreme events such as heat waves, droughts, fires, floods, landslides and storm surges. These conditions will increase stresses on water supplies and agriculture and will change natural ecosystems. Less seasonal snow cover and shrinking glaciers will create additional problems. Coastal areas are projected to be threatened by the consequences of rising sea levels and increasingly severe and more frequent storms and coastal flooding by 2050.

*Europe* will need to cope with retreating glaciers and extend of permafrost, reduced precipitation in Southern Europe and the possibility of more droughts in some areas, as well as increased risk of flash floods. Higher temperatures and heat waves will increase health risks and increase the frequency and severity of wildfires. Reduced forest area and agricultural productivity and greater vulnerability of low-lying coastal areas to rising sea levels are likely. Many economic sectors will be affected. For Southern Europe, less water will reduce hydropower potential, tourism and, in general, crop production.

*Latin America's* changes in precipitation patterns and the disappearance of glaciers will significantly reduce the amount of water available for human consumption, agriculture and energy generation. In drier areas, climate change is expected to lead to increased salinization and desertification of agricultural land. The productivity of some crops and livestock will decrease, with adverse consequences for food security. Rising sea levels will cause increased risk of flooding in low-lying coastal areas.

*North America* will experience further decrease of mountain snow due to rising temperatures leading to increased winter flooding and reduced summer flows, and to altered seasonal availability of water. Many areas are expected to experience more, longer and hotter heat waves, with a greater potential for adverse health impacts. Sustained higher temperatures also will increase the risk of forest fires. Coastal communities will be increasingly threatened if the intensity of tropical storms increases.

*Polar Regions* are likely to experience reductions in the thickness of glaciers and the extent of ice sheets, and changes in natural ecosystems. The impacts on human communities in the Arctic will be reflected in changes in infrastructure and traditional or indigenous ways of living.

*Small island states, coastal systems and other low-lying areas* are especially vulnerable to the effects of climate change, rising sea levels and extreme weather events. Millions of people are likely to be affected by floods, storm surges, erosion and other coastal hazards every year due to rising sea levels by the 2080s, particularly in the large deltas of Asia and Africa and the small island states. By mid-century, reduced water resources are expected in many small islands, e.g., in the Caribbean and Pacific.

<sup>12</sup> IPCC Fourth Assessment Report, Working Group II Report: <http://195.70.10.65/ipccreports/ar4-wg2.htm>.

## Climate change and disasters

### Weather factors that contribute to disasters

Natural hazards by themselves do not cause disasters – it is the combination of an exposed, vulnerable and ill-prepared population or community with a hazard event that results in a disaster. Climate change will therefore affect disaster risks in two ways, firstly through the likely increase in weather and climate hazards, and secondly through increases in the vulnerability of communities to natural hazards, particularly through ecosystem degradation, reductions in water and food availability, and changes to livelihoods. Climate change will add yet another stress to those of environmental degradation and rapid unplanned urban growth, further reducing communities' abilities to cope with even the existing levels of weather hazards.

Over the period 1991-2005, 3,470 million people were affected by disasters, 960,000 people died, and economic losses were US\$ 1,193 billion<sup>13</sup>. Poor countries are disproportionately affected, owing to intrinsic vulnerabilities to hazards and comparatively low capacities for risk reduction measures. Small countries are also particularly vulnerable - Grenada's losses of 919 US\$ million as a result of Hurricane Ivan in 2004 were equal to 2.5 times its GDP. Over the last two decades (1988-2007), 76% of all disaster events were hydrological, meteorological or climatological in nature; these accounted for 45% of the deaths and 79% of the economic losses caused by natural hazards. The likelihood of increased weather extremes in future therefore gives great concern that the number or scale of weather-related disasters will also increase. There is already evidence of increases in extreme conditions for some weather elements in some regions. The IPCC conclusions on changes in extreme conditions relevant to disaster occurrence are as follows:<sup>14</sup>

Many long-term precipitation trends (1900-2005) have been observed, including significant increases in eastern parts of North and South America, Northern Europe and Northern and Central Asia, and more dry conditions in the Sahel and Southern Africa, throughout the Mediterranean region, and in parts of Southern

Asia. The frequency of heavy precipitation events has increased over most land areas, which is consistent with global warming and the observed increases of atmospheric water vapour.<sup>15</sup>

More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Higher temperatures and decreased precipitation have increased the prevalence of drier conditions as well as contributing to changes in the distribution of droughts. Changes in sea surface temperatures, wind patterns, and decreased snow pack and snow cover also have been linked to changing drought occurrence.

Widespread changes in extreme temperatures have been observed in many regions of the world over the last 50 years; most notably the higher frequency of high-temperature days and nights and heat.

There is good evidence for an increase of the more damaging intense tropical cyclone activity in the North Atlantic since about 1970, which is correlated with increases in tropical sea surface temperatures. However, according to the IPCC, to date there is no clear trend evident in the global annual number of tropical cyclones.

### Outlook for disasters in a changing climate

It is impossible to be absolutely certain about all the disaster-related effects of climate change, owing to the intrinsic uncertainty in the climate projections, the diverse and rapidly changing nature of community vulnerability, and the random nature of individual extreme events. However, there is plenty of information on the serious impacts of events that have occurred in past decades, and on this basis alone there is much to be concerned about. By extrapolating this past experience to the conditions projected by the IPCC, and in the absence of measures to reduce disaster risks, the likely

<sup>13</sup> Hydrological, meteorological and climatological disasters include storm, flood, wet mass movement, extreme temperature, drought, and wildfire. Data downloaded from EM-DAT database, Centre for Research on the Epidemiology of Disasters (CRED), <http://www.emdat.be/>.

<sup>14</sup> IPCC Fourth Assessment Report, Working Group I Report: <http://195.70.10.65/ipccreports/ar4-wg1.htm>.

<sup>15</sup> The higher the temperature of the air, the greater the amount of water vapour it can hold (the increase being about 7% for each 1°C increase in temperature) and hence the greater amount of moisture available for precipitation.

consequences can be estimated in general terms as follows:<sup>16</sup>

More heat waves will increase the number of deaths, particularly among the elderly, the very young, or among people who are chronically ill, socially isolated or otherwise especially vulnerable.

Increased drought in some regions will likely lead to land degradation, damage to crops or reduced yields, more livestock deaths, and an increased risk of wildfire. Such conditions will increase the risks for populations dependent on subsistence agriculture, through food and water shortage and higher incidence of malnutrition, water-borne and food-borne diseases, and may lead to displacements of populations.

Increased frequency of high precipitation in some regions will trigger floods and landslides, with potentially large losses of life and assets. These events will disrupt agriculture, settlements, commerce and transport and may further increase pressures on urban and rural infrastructure.

Increases in the number and intensity of very strong cyclones (typhoons and hurricanes) will affect coastal regions, with potentially large additional losses of lives and assets.

Sea-level rise, coupled with coastal storms, will increase the impacts of storm surge and river flooding and damage livelihood systems and protective ecosystems. Low-lying settlements may become unviable, which may result in increased potential for movement of population and loss of infrastructure.

Higher temperatures and melting glaciers may cause glacial lake outbursts that could flood downstream settlements.

<sup>16</sup> For a complete listing of major projected impacts by sector, see IPCC Fourth Assessment Report, Working Group I, Summary for Policy Makers: <http://195.70.10.65/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf> and IPCC Fourth Assessment Report, Working Group II, Summary for Policy Makers: <http://195.70.10.65/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf>.

## Addressing the problem of climate change

### Mitigation and adaptation

Countries are actively discussing and negotiating ways to deal with the climate change problem, within the UNFCCC. The first task is to address the root cause by reducing greenhouse gas emissions from human activity. The means to achieve this are very contentious, as it will require radical changes in the way many societies are organized, especially in respect to fossil fuel use, industry operations, urban development and land use. Within the climate change arena, the reduction of greenhouse gas emissions is called “mitigation”.<sup>17</sup>

Mitigation is defined by the IPCC as “*an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks*”.<sup>18</sup> Examples of mitigation actions include more efficient furnace systems, developing new low-energy technologies for industry and transport, reducing consumption of energy-intensive products, and switching to renewable forms of energy, such as solar and wind power. Natural carbon sinks, such as forests, vegetation and soils, can be managed to absorb carbon dioxide, and technologies are being developed to capture carbon dioxide at industrial sources and to inject it into permanent storage deep underground.

The second task in responding to climate change is to manage its impacts. Future impacts on the environment and society are now inevitable, owing to the amount of greenhouse gases already in the atmosphere from past decades of industrial and other human activity, and to the added amounts from continued emissions over the next few decades until such time as mitigation policies become effective. We are therefore committed to

<sup>17</sup> Note that in the context of disasters, the term “mitigation” is defined differently, as “*any structural measures (such as engineering techniques and hazard-resistant construction) or non-structural measures (such as improved policies, legislation, public awareness, training and education, public commitment and operating practices) undertaken to limit the adverse impacts of natural hazards, environmental degradation and technological hazards*”. UNISDR Terminology on Disaster Risk Reduction (under development). Based on the 2004 Terminology: Basic terms of disaster risk reduction: <http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm>.

<sup>18</sup> The term greenhouse gas “sinks” means any process, activity, or mechanism that removes a greenhouse gas, an aerosol, or a precursor of a greenhouse gas or aerosol from the atmosphere. IPCC Fourth Assessment Report, Working Group II, Glossary of Terms: <http://195.70.10.65/pdf/glossary/ar4-wg2.pdf>.

changes. Taking steps to cope with the changed climate conditions is called “adaptation”.

Adaptation is defined by the IPCC as “*the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*”.<sup>19</sup> Examples of adaptation include preparing risk assessments, protecting ecosystems, improving agricultural methods, managing water resources, building settlements in safe zones, developing early warning systems, instituting better building designs, improving insurance coverage and developing social safety nets. These measures are intrinsically linked to sustainable development, as they reduce the risk to lives and livelihoods and increase the resilience of communities to all hazards. Ideally, adaptation and mitigation should be considered jointly, as some adaptation measures can contribute to reducing greenhouse gas emissions, while conversely mitigation measures can be planned to help reduce, and not inadvertently exacerbate, disaster risks.

### Adaptation through disaster risk reduction and the role of the Hyogo Framework

“Disaster risk reduction” can be defined as “*action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events*”.<sup>20</sup> It is therefore tailor-made to help counteract the added risks arising from climate change.

The Hyogo Framework for Action provides the foundation for the implementation of disaster risk reduction. Agreed at the World Conference on Disaster Reduction in January 2005, in Kobe, Japan, with the support of 168 Governments, its intended outcome for the decade is “*the substantial reduction of losses, in lives and in the social, economic and environmental assets of communities and countries*”. It specifically identifies the need to “*promote 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...*”.<sup>21</sup>

Based on a review of past successes and failures in reducing disaster risks, the Hyogo Framework sets out five priorities for action, each elaborated into a number of specific areas of attention. These offer a strong basis for developing concrete risk-reducing adaptation measures, for example:

**1: Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation.** This need is critical to both adaptation and risk reduction. Suggested actions toward achieving this priority include: encouraging a core ministry with a broad mandate including finance, economics or planning, to be responsible for mainstreaming climate change adaptation policies and activities; organizing a national high-level policy dialogue to prepare a national adaptation strategy that links with disaster risk reduction strategies; formalizing collaboration and the coordination of climate-related risk reduction activities through a multi-sector mechanism such as a national platform for disaster risk reduction; and developing mechanisms to actively engage women, communities and local governments in the assessment of vulnerability and impacts and the formulation of local adaptation activities.

**2: Identify, assess and monitor disaster risks and enhance early warning.** Important steps under this priority include developing and disseminating high-quality information about climate hazards and their likely future changes; conducting assessments of vulnerability and specially vulnerable groups; preparing briefings for policymakers and sector leaders; reviewing the effectiveness of early warning systems; implementing procedures to ensure warnings reach vulnerable groups; and undertaking public information programmes to help people understand the risks they face and how to respond to warnings.

<sup>21</sup> Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters (HFA), see part B, paragraph 4 (i) c): <http://www.unisdr.org/eng/hfa/hfa.htm>.

<sup>19</sup> IPCC Fourth Assessment Report, Working Group II, Glossary of Terms: <http://195.70.10.65/pdf/glossary/ar4-wg2.pdf>.

<sup>20</sup> UNISDR Terminology on Disaster Risk Reduction (under development). Based on the 2004 Terminology: Basic terms of disaster risk reduction: <http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm>.

**3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.**<sup>22</sup> This principle applies equally to adaptation and disaster risk reduction. Specific steps should include collating and disseminating good practices; undertaking public information programmes on local and personal actions that contribute to safety and resilience; publicizing community successes; training the media on climate-related issues; developing education curricula on climate adaptation and risk reduction; supporting research programmes on resilience; and improving mechanisms for knowledge transfer from science to application for risk management in climate-sensitive sectors.

**4: Reduce the underlying risk factors.** This covers the many environmental and societal factors that create or exacerbate the risks from natural hazards. Measures can include incorporating climate risk-related considerations in development planning processes and macro-economic projections; requiring the use of climate risk-related information in city planning, land-use planning, water management, and environmental and natural resource management; strengthening and maintaining protective works such as coastal wave barriers, river levees, flood ways and flood ponds; requiring routine assessment and reporting of climate risks in infrastructure projects, building designs, and other engineering practices; developing risk transfer mechanisms and social safety nets; supporting programmes for diversification of livelihoods; and instituting adaptation activities in plans for recovery from specific disasters.

**5: Strengthen disaster preparedness for effective response at all levels.** Resilience building and early warning systems contribute to this priority. Other specific actions can include revising preparedness plans and contingency plans to account for the projected changes in existing hazards and new hazards not experienced before; building evacuation mechanisms and shelter facilities; and developing specific preparedness plans for areas where settlements and livelihoods are under threat of permanent change.

<sup>22</sup> The term “at all levels” encompasses community, municipal, province, national regional and international levels.

## Practical examples of adaptation and disaster risk reduction

**Agriculture and food security:** Well-known measures include altering crop strains to enhance their drought and pest resistance, changing planting times and cropping patterns, and altering land topography to improve water uptake and reduce wind erosion. Burkina Faso is one country which is researching new drought-resistant millet and sorghum for decreased rainfall regimes.<sup>23</sup> Diversification is an option, for example, by combining food crops, livestock and agro-forestry. The introduction of insurance schemes can help people cope with crop losses.

**Water sector:** Adaptation measures include actions on both water supply and water risks, such as protecting water supply infrastructure and traditional water supply sources, developing flood ponds, water harvesting, improved irrigation, desalination, non-water-based sanitation and improved watershed and trans-boundary water resource management. Integrated water resource management (IWRM) provides the accepted framework for such actions.

**Health sector:** Measures include early warning systems and air-conditioning to address extreme weather events; systematic action on water- and vector-borne diseases to raise public awareness of watershed protection, vector control, and safe water- and food-handling regulations; the enforcement of relevant regulations; and support for education, research and development on climate-related health risks. As one example, Philadelphia (USA) developed an excessive heat event notification and response programme to reduce the number of fatalities caused by future heat waves in response to the heat-related deaths during the summer of 2003.<sup>24</sup>

**Awareness raising and education:** Measures include curriculum development for schools, supply of information to community groups and women’s networks, radio and television programmes, public poster campaigns, and leadership by national figures and celebrities. Awareness-raising for strategic intermediaries such as teachers, journalists and politicians and support to technical experts and groups are also important.

<sup>23</sup> Linking Disaster risk Reduction, Climate Change and Development, Global Platform for Disaster risk Reduction, Information Note 1: [http://www.preventionweb.net/globalplatform/first-session/docs/media\\_docs/Info\\_Note\\_1\\_HL\\_dialogue\\_Climate\\_Change.pdf](http://www.preventionweb.net/globalplatform/first-session/docs/media_docs/Info_Note_1_HL_dialogue_Climate_Change.pdf).

<sup>24</sup> U.S. Environmental Protection Agency. (2006): Excessive Heat Event Guidebook. United States Environmental Protection Agency Office of Atmospheric Programs, Washington D.C.: [http://www.epa.gov/heatisland/about/pdf/EHEguide\\_final.pdf](http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf).



**Environmental management:** Healthy ecosystems provide significant benefits for resilience, livelihoods, risk reduction and adaptive capacity. Measures include strengthening of environmental management in areas of greatest risk from weather hazards; protecting ecosystems, such as coral reefs or mangrove forests, that shield communities from coastal hazards; supporting transitions of livelihoods away from those that degrade environments and aggravate risk; and enforcing regulations concerning these practices.

**Early warning systems:** Measures include improving existing systems to cover the changed hazard circumstances, instituting specific means to disseminate warnings to affected people in a timely, useful and understandable way, and providing advice on appropriate actions to take upon receiving warnings. Heat wave early warning systems, for instance, have been developed in France after the heat wave of 2003.

**Development planning and practices:** Adaptation and disaster risk reduction measures can be made a formal part of development processes and budgets and programmed into relevant sector projects, for example in the design of settlements, infrastructure, coastal zone development, forest use, etc., in order to achieve sustainable land management, avoid hazardous areas, and build safe schools, hospitals and other public facilities.

### Cost-effectiveness of disaster risk reduction as an adaptation measure<sup>25</sup>

Disaster risk reduction offers cost-effective approaches to reduce the negative impacts of flooding, landslides, heat waves, temperature extremes, droughts and intense storms. The benefits can be calculated not only in money saved, but also in more secure livelihoods and saved lives. Some examples include:

- China spent US\$3.15 billion on flood control between 1960 and 2000, which is estimated to have averted losses of about US\$12 billion.
- The Rio de Janeiro flood reconstruction and prevention project in Brazil yielded an internal rate of return exceeding 50%.
- The disaster mitigation and preparedness

programmes in Andhra Pradesh, India yielded a benefit/cost ratio of 13.38.

- A mangrove-planting project in Vietnam aimed at protecting coastal populations from typhoons and storms yielded an estimated benefit/cost ratio of 52 over the period 1994 to 2001.
- Property-owners in the US Gulf States who implemented hurricane protection methods employed at nearly 500 locations avoided US\$500 million in property losses from Hurricane Katrina, after customer investments of only US\$2.5 million. These customers sustained eight times less damage than those who choose not to implement the protection measures.<sup>26</sup>

### Disaster risk reduction and the UNFCCC process

The UNFCCC Parties have recognized that existing knowledge and capacities for coping with extreme weather events must be harnessed to adapt to climate change. The Bali Action Plan's directions for adaptation call for the consideration of:

*“Risk management and risk reduction strategies, including risk sharing and transfer mechanisms such as insurance;*

*Disaster reduction strategies and means to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change.”<sup>27</sup>*

Also, many of the general principles and requirements for adaptation that are listed in the Bali Action Plan are highly relevant to reducing disaster risk, particularly vulnerability assessments, capacity-building and response strategies, as well as integration of actions into sectoral and national planning.

The need to systematically integrate disaster risk reduction and adaptation into national development strategies has also emerged as a key conclusion from

26 Mills, E., Lecomte, E. (2006): From Risk to Opportunity: How Insurers Can Proactively and Profitably Manage Climate Change. [http://eedt.lbl.gov/EMills/PUBS/PDF/Ceres\\_Insurance\\_Climate\\_Report\\_090106.pdf](http://eedt.lbl.gov/EMills/PUBS/PDF/Ceres_Insurance_Climate_Report_090106.pdf).

27 At the 13<sup>th</sup> Conference of the Parties (COP), Bali, December 2007, the “Bali Action Plan” was adopted. It provides the roadmap toward a new international climate change agreement to be concluded by 2009, and that will ultimately lead to a post-2012 international agreement on climate change. In paragraph 1c, the Bali Action Plan highlights the significance of disaster risk reduction, as part of enhanced action on climate change adaptation. <http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf#page=3>.

25 Cited in the Stern Review, Report on the Economics of Climate Change (2006): [http://www.hm-treasury.gov.uk/independent\\_reviews/stern\\_review\\_economics\\_climate\\_change/stern\\_review\\_report.cfm](http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm).

a number of recent international policy forums. In particular, the “Stockholm Plan of Action for Integrating Disaster Risk and Climate Change Impacts in Poverty Reduction”<sup>28</sup> and the recent Oslo Policy Forum on “Changing the Way We Develop: Dealing with Disasters and Climate Change”<sup>29</sup> reiterated this view.

In support of the Bali Action Plan, and based on consultation with ISDR system partners and UNFCCC Parties, the UNISDR has identified and promoted the following three areas of action over 2008.<sup>30</sup>

- ***Develop national coordination mechanisms to link disaster risk reduction and adaptation.***

This can be done for example through convening interdepartmental and national consultation meetings with personnel from the fields of disaster risk reduction, climate change and development, formally cross-linking the national platform for disaster risk reduction and the national climate change team, and

<sup>28</sup> Stockholm Plan of Action for Integrating Disaster Risks and Climate Change Impacts in Poverty Reduction: <http://www.unisdr.org/partner-net/wb-isdr/docs/Stockholm-Plan-of-Action.pdf>.

<sup>29</sup> Report on the findings of the Conference: Changing the Way We Develop: Dealing with Disasters and Climate Change: <http://tsforum.event123.no/UD/OPF08/pop.cfm?FuseAction=Doc&pAction=View&pDocumentId=15358>.

<sup>30</sup> “Sub-paragraphs 1(c) (ii, iii) of the Bali Action Plan: Background and Options for Reducing Disaster Risks”. Informal paper prepared by secretariat of the International Strategy for Disaster Reduction (UN/ISDR) for UN Climate Conference, Bangkok, 1-5 April, 2008, 6pp.

encouraging systematic dialogue and information exchange between climate change and disaster reduction bodies, focal points and experts.

- ***Conduct a baseline assessment on the status of disaster risk reduction and adaptation efforts.*** This involves efforts by countries to collect and summarise national risk information, including socio-economic data concerning vulnerability and institutional capacities, together with reviews of relevant existing policies, particularly development strategies and sector plans, Hyogo Framework implementation, adaptation programmes, and national risk transfer mechanisms.

- ***Prepare adaptation plans drawing on the Hyogo Framework.***

Based on the assessment of needs and gaps, this task could include the joint development of a disaster reduction plan and an adaptation plan. It should capitalize on National Adaptation Plans of Action where present and other adaptation initiatives, and should use the concepts and language of the Hyogo Framework where appropriate, ideally with action on all five of the Hyogo Framework’s priorities, to ensure a comprehensive, integrated and systematic approach to adaptation.

## Concluding remarks

The topic of climate change will see great debate and rapid changes in thinking over the months leading up to the UNFCCC Conference of the Parties in Copenhagen in December 2009. The issue of vulnerability to natural hazards and disaster risks must remain central to the discussions, and progress must be made to effectively and fairly address the increased risks. But it is not necessary to wait until 2010 to act – disaster risk reduction can be implemented immediately, under

the guidance of the Hyogo Framework, to provide adaptive capacity, to increase resilience to future threats, and to reduce the existing unacceptable and growing levels of disaster risk.

For more information on these topics, please explore the following web sites: [www.ipcc.ch](http://www.ipcc.ch), [www.unfccc.int](http://www.unfccc.int), [www.unisdr.org](http://www.unisdr.org), [www.preventionweb.net](http://www.preventionweb.net), [www.emdat.be](http://www.emdat.be), [www.un.org/climatechange/](http://www.un.org/climatechange/).



United Nations  
International Strategy for Disaster Reduction

International Environment  
House II, 7-9 Chemin de Balexert, CH 1219  
Chatelaine, Geneva 10, Switzerland  
New phone and fax numbers:  
Tel: +41 22 917 8908/8907  
Fax: +41 22 917 8964  
[isdr@un.org](mailto:isdr@un.org)

Postal Address:  
UNISDR  
Palais des Nations  
CH-1211 Geneva 10, Switzerland