Climate Change and Poverty

A discussion paper

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Tearfund discussion papers are short exploratory research papers aimed at provoking wider discussion of development-related issues among Tearfund staff and the organisations and individuals with which Tearfund works. They do not necessarily constitute Tearfund policy. Comments from readers are welcomed.

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Introduction

"It is no longer a question of whether the earth's climate will change but rather when, where and by how much" Robert T. Watson, Chairman of the United Nations Inter-Governmental Panel on Climate Change.[1]

Up until the late eighties, convincing evidence supporting the theory of global warming (or climate change as it is now more commonly referred to) was lacking and as a result politicians were adopting a 'wait and see' attitude. In 1988, the evidence 'came in with a bang' at a conference in Toronto and was so disturbing that climate change was pushed firmly onto the political agenda.[2] Today climate change is almost universally accepted as fact, with scientists declaring it to be not just possible but 'inevitable'.[3] The world is already experiencing the effects of rising temperatures and, as the Intergovernmental Panel on Climate Change (IPCC)[4] predicts, these effects will intensify over the next few decades.

While climate change has traditionally been perceived as a largely environmental concern, this perception has changed too in recent years with the issue being increasingly taken up by the development community. The IPCC's assessments of the impact that climate change is likely to have on the poor make disturbing reading. Climate change has been linked to the dramatic increase in extreme weather events witnessed by the developing world in recent years: disasters such as floods and droughts have already killed and affected millions, and these are predicted to escalate in frequency and intensity. Other effects of climate change include food insecurity, ill health, loss of forests and biodiversity, social and political instability and economic decline, all of which will hit the poorest hardest. Climate change, therefore, is one of the greatest threats facing the poor in the 21st century.

The aim of this paper is to raise awareness among Tearfund and partners of how climate change could affect the poor living in Latin America, Africa (particularly southern Africa) and Asia by describing some of the impacts that it is likely or expected to have on them. Through doing this, the paper draws attention to the fact that climate change is, and must be considered as, a key development issue. The predictions of the IPCC act as a warning to policy makers and NGOs alike; unless these warnings are heeded and climate change impacts are factored into local, national, regional and global policy, planning and practice, relief and development will not be sustainable.

This paper is divided into four sections. The first covers the causes of climate change and general predictions of its impacts. The second and third sections discuss the implications of climate change for sustainable development within Latin America, Africa and Asia, with a particular focus on extreme weather events in section two and on economic impacts in section three. The fourth section describes international climate change mitigation processes, adaptation strategies and policy influencing opportunities. The paper ends with some discussion points and ideas for further reading.

This paper is not intended to offer a definitive guide to regional climate change, for the IPCC and other researchers offer much information that cannot be included here. With reference to Asia in particular, the IPCC divides the continent into 'tropical', 'temperate' and 'arid' and describes detailed impacts for each. Other resources divide Asia into geographical zones and describe impacts accordingly. It has not been possible, therefore, to enter into the kind of detail that the size and regional variability of the continent merits, and options for further research (including on the other two regions) are offered at the end of this paper.

Executive Summary

Section 1:

Scientific and observational evidence reveals that climate change is affecting the world. Global temperatures and sea-levels have risen over the 20th century, and Latin America, Africa and Asia have all experienced changes in temperature and rainfall. Human activity is responsible for global warming, the primary polluters being industrialised nations. Global temperatures and sea-levels will continue to rise in the future. General predictions on sea level rise, rainfall and temperature are given for each region.

Section 2:

The poor will be the most harmed by climate change. Global warming is linked to extreme weather events, and global droughts and floods are expected to increase. Latin America, Africa and Asia are all at risk from sea level rise and flooding to greater or lesser degrees. All three regions are also likely to experience intensified water shortages, and decreased food security. Each region is threatened by an increase in vector borne diseases such as malaria. Floods and droughts may also increase the incidence of disease, particularly floods which spread water-borne infections. Climate change is expected to deplete and change the composition of forests in all three regions. Loss of biodiversity and ecosystems as a result of climate change may impact rural livelihoods and health.

Section 3:

The social costs of climate change are predicted to be migration and aggravation of urban poverty. Countries may find themselves in conflict over increasingly scarce food and water supplies, as well as a dramatic increase in the number of environmental refugees. Economic costs associated with climate change are varied, ranging from loss of infrastructure to higher insurance premiums and loss of national GDP. Disasters threaten the global economy. Losses to the tourist industry in each region may arise from coastal destruction, loss of wildlife, loss of water resources, and coral reef destruction.

Section 4:

The aims and mechanisms of the Kyoto Protocol are discussed, including the controversy surrounding the use of 'carbon sinks' such as forests to offset emissions targets. The USA is the Protocol's primary opponent. Examples of arguments raised against the Protocol are given and counter-arguments provided. Adaptation to climate change is a priority; disaster mitigation and preparedness (DMP) is a vital component of adaptation and must be undertaken at national and local levels. A wide range of DMP measures are available and examples of these are given. DMP must be included in developing countries' Poverty Reduction Strategy Papers (these are explained). Climate change and DMP must also be integrated into sectoral and cross sectoral policies and strategies, including disaster management. Governments must be held accountable for agreements made on DMP at the World Summit on Sustainable Development.

Climate change is a key development issue that must be addressed as a matter of urgency. Governments, business and individuals must all commit to mitigating climate change through reducing greenhouse gas emissions. As the effects of climate change are already affecting the poor, the implementation of adaptation measures is essential. The threat of climate change must be factored into all local and national development decisions. If climate change is not addressed in these ways, progress will not be made in the developing world.

Section 1: The Reality of Climate Change

The evidence for climate change

Evidence presented by the Intergovernmental Panel on Climate Change (IPCC) reveals that the world's climate is changing. The strength of the evidence presented by the IPCC is such that very few policy makers or academics now deny the realities of global warming. As Sir John Houghton, co-chairman of the IPCC's Scientific Assessment Working Group, states, 'Although there is a lot of uncertainty concerning the detail, the basic science underlying global warming and climate change is well understood and is not in question'.[5] The following global statistics, produced by the IPCC in 2001[6], reveal how the world's climate has changed over the last 200 years:

- The global average surface temperature has increased since 1861. Over the 20th century, there was an increase in temperature of around 0.6?C

- Since 1950, it is very likely[7] that there have been fewer extreme low temperatures and an increase in the frequency of extreme high temperatures

- It is very likely[8] that, globally, the 1990s was the warmest decade and 1998 the warmest year since 1861

- It is very likely[9] that there have been decreases in snow cover by around 10% since the late 1960s. In non-polar regions there has been a widespread retreat of mountain glaciers in the 20th century

- Global average sea level rose between 0.1 and 0.2 metres during the 20th century, and global ocean heat content has increased since observations began in the late 1950s

- Warm episodes of the El Nino-Southern Oscillation have been more frequent and intense since the mid-1970s in comparison with the previous 100 years

Latin America

- Changes to the climate in Latin America over the last 100 years have included a rise in the average surface temperature (especially at middle and high latitudes), and changes in the rate and intensity of precipitation in several countries, such as southern Brazil, Paraguay, and Argentina.[10]

Southern Africa

- In southern Africa, temperatures have risen by over 0.5?C over the last 100 years, with noticeably less rainfall over the past 20 years.[11]

Tropical Asia[12]

- Average surface temperatures have increased in the range of 0.3– 0.8?C over the last 100 years. Many countries have shown a decreasing trend in rainfall in the last three decades.[13]

Temperate Asia[14]

- Annual average temperature has increased by over 1?C, this increase being most noticeable since the 1970s. Sub-regionally, there have been both increases and decreases in rainfall.[15]

Arid Asia[16]

- Central Asia has witnessed a 1-2?C temperature increase over the last century.[17]

Apart from the scientific evidence, observational evidence indicates that climate change has already had an effect on physical and biological systems throughout the world. Examples of these observed changes include '…lengthening of mid to high-latitude growing seasons, poleward and altitudinal shifts of plant and animal ranges, declines of some plant and animal populations, and earlier flowering of trees, emergence of insects, and egg-laying in birds'.[18] Moreover sea levels have shown signs of rising, and in some regions, including within Africa and Asia, floods and droughts have been observed to increase in recent years. Many rural farmers in developing countries, and Tearfund partners, are already seeing the effects of climate change daily in the reduced availability of water for their agriculture.

The causes of climate change

Evidence strongly suggests that humans have exerted, and continue to exert, an influence on the world's climate. The IPCC asserts that the warming of the last 100 years was 'unusual' and unlikely[19] to be natural in origin, and has attributed the warming of at least the second half of the century to an increase in greenhouse gases (carbon dioxide, methane and nitrous oxide) in the atmosphere.[20] Human activity is largely responsible for these gases: CO_2 is produced by the burning of fossil fuels (coal, oil and gas) as well as land-use change such as deforestation; methane is produced by cattle, rice agriculture, fossil fuel use and landfills, and nitrous oxide is produced by the chemical industry, cattle feed lots and agricultural soils. As humans have increased their levels of production and consumption, greenhouse gas emissions have also increased; since 1750, at the time of the Industrial Revolution, CO_2 has

increased by 31%, methane by 151% and nitrous oxide by 17%.[21] Moreover, graphs produced by the IPCC reveal that anthropogenic (human-induced) emissions continue to rise steadily ; present CO_2 levels, for example, have 'not been exceeded during the past 420,000 years'.[22] The IPCC's confidence that humans exert an influence on the world's climate leads it to state: 'The balance of evidence suggests a discernible human influence on global climate' with '…new and stronger evidence that most of the warming over the last 50 years is attributable to human activities'.[23] It is on the strength of the evidence presented by the IPCC that governments around the world have pledged to reduce their national greenhouse gas emissions in a bid to slow down the process of climate change.

CO_2 polluters

CO_2 accounts for over 80% of the pollution leading to global warming,[24] and statistics reveal that collectively, industrialised countries are its largest emitters. Indeed, they produce 25 times more CO_2 per head of population than developing countries.[25] The disproportionately large quantity of CO_2 produced by industrialised countries is revealed by The Hadley Centre[26], which shows that in 1996, the USA produced 5,300,990 metric tonnes of CO_2, the UK produced 556,983 metric tonnes, while Pakistan produced 94,333 metric tonnes and Bangladesh 22,959 metric tonnes.[27] The disparity is also revealed by the fact that approximately 20% of the world's population live in industrialised nations, yet they consume almost 80% of global energy.[28]

The five largest emitters of CO_2 per capita are the USA, the UK, Japan, Germany and Canada[29] with the USA alone emitting one-quarter of global greenhouse gas emissions.[30] In fact, the USA with a population of 300 million 'produces as much carbon dioxide as 135 developing countries with a combined population of 3 billion'.[31] As for Latin America and Africa, their contribution to global warming is very small when compared with that of the USA and the UK. The whole of Latin America contributes only around 4% of global emissions,[32] (equal to the amount produced by the UK) while the entire continent of Africa contributes 3.5%.[33] India is home to 17% of the world's population yet it only emits 4.2% of global greenhouse gases.[34]

Climate change predictions

Global predictions

The IPCC's climate change predictions are based on a 'wide range of scenarios of future emissions of greenhouse gases and aerosols', which all assume that business will continue as usual and concentrations of atmospheric CO_2 will rise to 90 to 250% above that of the year

1750.[35] For all the scenarios studied, both temperature and sea levels are expected to rise over the 21st century.

Specifically, the IPCC predict that globally averaged surface air temperature is projected to rise by 1.4 to 5.8?C by the year 2100 and globally averaged sea level by 0.09 to 0.88m by the same year.[36] Although this predicted temperature increase may not seem very large, as Sir John Houghton observes, 'Between the middle of an ice age and the warm periods in between ice ages, the global average temperature changes by only about 5 or 6?C'. If a 2.5?C rise is experienced, this 'represents about half an 'ice age' in terms of climate change. For this to occur in less than 100 years…is very rapid change'.[37]

The rate of acceleration of warming depends upon how fast global greenhouse gas emissions can be brought under control. If gas concentrations in the atmosphere could be stabilised at their existing levels, global temperatures would rise at a rate of only a few tenths of a degree per century as opposed to several degrees under current predictions.[38] However, as carbon dioxide remains in the atmosphere for at least a century, emissions of the gas would have to be immediately reduced by more than half just to stabilize temperatures at existing levels. Moreover, the Hadley Centre observes that even if climate change could be halted today, the surface warming of the oceans that has already occurred will continue to raise sea levels for at least 500 years.[39]

Another factor that could influence the acceleration of warming is the release of carbon currently stored in the world's forests, soils, oceans and permafrost regions. The carbon held by these natural reservoirs is enormous; the world's oceans, for example, contain nearly 40,000 billion tonnes (the earth's atmosphere currently contains just 750 billion tonnes.[40] With rising temperatures, quantities of this carbon could be released into the atmosphere and so intensify global warming. This factor has been largely left out of the IPCC's calculations: if it were included, some climatologists predict that there could be a 10-14ºC change in temperature by the end of the 21st century. If they are right, the threat of climate change on the world's weather and people is far greater than is currently anticipated.[41]

Regional predictions

Uncertainties in global climate models (GCMs) make it impossible to present definitive regional climate change predictions. Within this context, the IPCC has predicted the following climate scenarios:[42]

Latin America

- Intensified and extended dry seasons are predicted for Latin America's semi-arid sub-tropical zone

- Some regions of Latin America will experience increased rainfall

- A possible rise in sea levels of, on average, about 5mm a year (best estimate of 2-5 times the rate of the last 100 years)

Africa

- Land areas may warm by as much as 1.6ºC over the Sahara and semi-arid regions of southern Africa by 2050

- Rainfall is expected to increase over Africa except in southern Africa and parts of the Horn, where rainfall is projected to decline by about 10% by 2050

- Sea level is projected to rise around 25cm by 2050

Tropical Asia

- Scenarios suggest that temperature will increase throughout most of the region but this will be less than the global average

- Rainfall is expected to decline or increase according to sub region

- The IPCC predict that there could be increased variability of the Asian summer monsoon precipitation, leading to increased flood and drought magnitude in tropical and temperate Asia[43]

Temperate Asia

- At the time when levels of CO_2 double, warming between 2 and 3ºC over the annual average of the region is expected. (Warming will be greater in arid/semi arid and Siberian regions than the coastal monsoon region)

- Sea levels are expected to rise by 1.0 – 2.5 mm per year (which represents a rate two to five times higher than that of the last 100 years)

Arid Asia

- Climate models predict that temperatures will rise by 1-2º C by 2030-2050

- Changes in precipitation are variable and 'unlikely to be significant'

- Higher evaporation rates will lead to decreased soil moisture in most parts of the region

Section 2: The Implications of Climate Change for Sustainable Development

Poverty

Global warming may bring some benefits to certain regions of the world, such as reducing the effects of winter diseases and enhancing high latitude agriculture. However the IPCC states clearly that, 'more people are projected to be harmed than benefited by climate change'.[44] Those that will be harmed the most are those living in developing countries, particularly the very poor. As the IPCC observes, 'The effects of climate change are expected to be greatest in developing countries in terms of loss of life and relative effects on investment and the economy'.[45] The reason for this is that developed countries have a far greater ability to adapt to climate change and mitigate its effects (such as floods and droughts) than developing countries. Proof of this can be found in statistics produced by the Red Cross, which reveal that 22.5 people die per reported 'natural' disaster in highly developed nations, 145 die per reported disaster in nations of medium human development, while each disaster in countries of low human development claims an average of 1,052 people.[46]

The flooding that occurred in Brazil in 1988 was a clear demonstration of this disparity between the capacity of the rich and the poor to cope with climate extremes. Although heavy rains fell on both rich and poor neighbourhoods in 1988, the poor suffered disproportionately. The houses of the rich were built to withstand the flood waters, and were in areas less susceptible to run-off and where local infrastructure could function properly. The poor, however, lived in weaker housing, on marginal land, and were ill-informed of how they could protect themselves. They could not move to upper storeys as their houses were built on one level, they lacked insurance for rebuilding, and through illiteracy or ignorance they were generally not able to take advantage of government rehabilitation aid. Lack of insurance is a significant factor in increasing the vulnerability of the poor to disasters. As stated in the World Disasters Report 1999, 'In richer countries, insurance is a major component of disaster preparedness, but for millions of people in the developing world insurance is an unaffordable luxury'.[47] When Hurricane Mitch struck Central America in 1998, it caused $7 billion of economic damage, of which only $150 million was covered by insurance.[48]

Studies undertaken by climatologists at the University of East Anglia confirm that poor nations are by far the most vulnerable to climate change. By weighing up national wealth against the increases in temperature predicted by the IPCC, they have found that the three countries most vulnerable to climate change during the 21st century will be developing ones: Sierra Leone, Ethiopia and Afghanistan.[49]

Disasters

Climate change has many serious implications for development. One of these is an increase in the number of severe weather events such as floods and droughts as a result of increases in global temperature. The link between global warming and extreme weather events is suggested by IPCC data; the IPCC has observed higher maximum[50] and higher minimum[51] temperatures over nearly all land areas during the latter half of the twentieth century, and an increase in intense precipitation events and risk of drought over some areas in the same period.[52] The IPCC's confidence in the correlation between warmer temperatures and extreme weather leads it to state: '…some extreme events are projected to increase in frequency and/or severity during the 21st century due to changes in the mean and/or variability of climate, so it can be expected that the severity of their impacts will also increase in concert with global warming'.[53]

The IPCC predicts that global warming will precipitate the following extreme events over the 21st century:

- Increased summer drying over most mid-latitude continental interiors and associated risk of drought (likely[54])
- Increase in tropical cyclone peak wind intensities, and mean and peak precipitation intensities (likely, over some areas[55])
- Increased risk of floods and droughts associated with El Nino events in many different regions (likely[56]) [57]

Disaster statistics produced by the International Federation of Red Cross and Red Crescent Societies (IFRC) seem to support the observations of the IPCC, for they reveal a rising trend in the number of hydro-meteorological disasters over the second half of the 20th century during which there was also a rise in global temperatures.[58] 1998 was recorded as the hottest year of the century, and it was also a record year for disasters: Hurricane Mitch in Central America; flooding in China; huge forest fires in Mexico, Brazil, and the USA; killer heat waves in India and the Middle East; and the harshest drought for 70 years in Mexico.[59] This rising trend in disasters cannot be *solely* attributed to global warming, however, as a disaster is the result of an extreme weather event combined with vulnerability. Factors contributing to vulnerability include population growth, use of land that is prone to flooding, environmental destruction (such as deforestation), soil erosion, and lack of disaster preparedness. If vulnerability is decreased or eradicated, a disaster may be prevented.

The statements and observations of the IPCC, as well as many other institutions and NGOs, leave little doubt over the link between the warming climate and the increasing incidence of disasters. As stated in the World Disasters Report 2001: 'The planet's poorest are becoming ever more exposed to the risk of disaster – aggravated by the volatile effects of climate change (and economic globalisation)'.[60] When increasing vulnerability to disasters as a result of population expansion and other factors is also taken into account, 'the world is at risk as never before'.[61]

Sea-level rise and floods

Over the last century, global tides have risen by an average of around 20 cm.[62] This rise in sea levels has been linked to global warming by the IPCC which states that, as a result of large-scale loss of land ice and thermal expansion of sea water, '…it is very likely[63] that the 20th century warming has contributed significantly to the observed sea-level rise…'.[64]

Sea-level rise and flooding are already affecting millions of people world-wide. According to the IFRC, 10 million people are at constant risk from coastal floods, and floods in general are making 3 million people homeless every year.[65] Moreover, the number of those affected by sea-level rise and floods is increasing rapidly: 1998 saw the most catastrophic floods of the century, with up to 300 million people affected by torrential rains, storm surges, landslips, mudslides and tidal waves.[66]

Floods are usually considered to be the most deadly of all natural disasters.[67] Not all floods are destructive: some annual ones (such as the Nile floods before the Aswan High Dam was built) help to maintain soil fertility. Destructive floods tend to be rainfall induced river floods, flash floods, storm surges and tidal floods. These can be viewed as the enemies of sustainable development, destroying life and livelihoods and setting back development by decades.

Global average precipitation is projected to increase during the 21st century[68] and sea-levels are expected to rise by 20-100 cm before 2100.[69] As a result, the IPCC predict that there will be a 'widespread increase in the risk of flooding for many human settlements'.[70] Indeed, according to the IPCC flooding and landslides pose 'the most widespread direct risk to human settlements from climate change'.[71] With half of the world's population living in coastal regions, flooding due to storm surges already affects around 46 million people a year, mostly in developing countries. Studies suggest that with a 50 cm sea-level rise, this figure could double to 92 million.[72] Indeed, it is estimated that by 2025 *over half* of all people living in developing countries will be highly vulnerable to floods and storms.[73]

Regional Analysis

The regions to be most affected by sea-level rise are heavily populated areas of low lying land such as southern Bangladesh, parts of eastern China, the Nile delta and many islands of the South Pacific and Indian Oceans, as well as the low lying coasts in western Africa from Senegal to Angola, in South America from Venezuela to Recife in Brazil, and much of the coastlines of Indonesia and Pakistan.[74]

Regional predictions of sea-level rise and floods are as follows:[75]

Latin America

The rate of sea-level rise over the last 100 years in Latin America was 1.0-2.5 mm a year. The IPCC states that this rate could now rise to 5 mm per year.

According to the IPCC's predictions, some coastal sectors on the Atlantic side of South America and in Central America would be at risk from inundation due to rising sea levels. In Central America, sea-level rise would have the greatest impact on coastal infrastructure, agriculture and natural resources in the coastal zone. Sea-level rise would also 'exacerbate the processes of coastal erosion…and increase flooding risks and the impacts of severe storms along the coastline'. In Latin America as a whole, flat areas including river mouths and river deltas such as the Amazon, Orinoco and Parana would also be affected, and saltwater intrusion would affect estuaries such as the Rio de la Plata, causing problems for the supply of freshwater. The strength of all these effects, however, will depend on the amount of sea-level rise as well as atmospheric and oceanic circulation.

Sea-level rise can result in actual land loss. This would have a major impact on areas where there are large human settlements, infrastructure and tourist resorts. The IPCC has estimated impacts of a 1.0m sea level rise on several Latin American countries. The following statistics reveal the predicted implications of a 1.0m rise in Guyana (assuming that no adaptive measures have been adopted):

Land loss: 2,400 square km
Wetland loss: 500 square km
People affected: 600,000 % total: 80
Financial loss: 4,000 million US dollars % GNP: 1,115

Internal flooding (as opposed to coastal) is already a major problem in Latin America both in cities and mountain regions, and is likely to worsen with climate change. In recent years hundreds of people have been killed and thousands made homeless by landslides in Rio de Janeiro, Guatemala City, Mendoza, Mexico City, Santos and Sao Paulo. The frequency of flooding in shantytowns (which are sometimes built in the drainage valleys of rivers and streams) is already increasing 'as a result of climatic variability', and 'might be exacerbated as a result of global warming'.

Africa

Africa's coastal area is already experiencing many environmental problems - coastal erosion, flooding, saltwater intrusion and subsidence - as a result of population pressures and exploitation of coastal resources. Climate change can be expected to intensify these problems, for the IPCC predicts 'climate change will exacerbate existing physical, ecological/biological, and socio-economic stresses on the African coastal zone'.

The west coast of Africa is currently affected by storm surges and is at risk from extreme storm events, erosion and inundation. With climate change, tidal waves and storm surges may increase and inundation could become a major concern. Many major cities in this region situated at sea level would be vulnerable. East Africa's coastal zone will also be affected: climatic variation and sea-level rise may decrease coral and patch reefs along the continental shelf, reducing their buffer effects and increasing the likelihood of east coast erosion. Sea levels are expected to rise by 1 metre, and this combined with population growth in the main east coastal cities could have a significant negative impact on the area.

In order to understand the implications of a 1 metre sea-level rise in greater detail, the IPCC has estimated the effect that a sea-level rise of 0.5 and 1.0m respectively - per century - would have on the coastline of Tanzania:

0.5 m sea-level rise = around 2,090 km² of inundated land
1m sea-level rise = about 2,117 km² of inundated land
1m sea-level rise = another 9 km² of land would be eroded

Projected damage:
0.5 m rise = 50 billion Tanzanian shillings (Tsh)
1 m rise = 86 billion Tsh

As for precipitation related flooding, the IPCC admits that 'little can be said yet' about extreme events in Africa. Nevertheless it is worth noting that southern Africa has already experienced an increase in precipitation and flooding. In the rainy season of October 1999 - March 2000, intense rainfall occurred throughout southern Mozambique, northern South Africa and southeast Zimbabwe, with many places having their worst rains for 20-50 years. Rainfall over the South of Mozambique was almost triple average levels, and precipitated the flooding of January to March 2000 which killed 700 people.[76] Major floods were rare in Mozambique for over 50 years, yet in the late 20th century floods increased in frequency and severity. South Africa also suffered an increase in severe rainfall and floods during this period, with the number of rain events rising dramatically after 1971.[77] Zululand University has attributed these changes to global warming, stating that in Mozambique, the latter part of the 20th century has witnessed 'an upward trend of extreme rainfall consistent with global warming and locally increased sea temperatures in the Mozambique Channel'.[78]

Tropical Asia

Tropical Asia's climate is dominated by two monsoons - the summer southwest and the winter northeast – which bring much of the region's rain. A large proportion of tropical Asia is exposed to yearly floods, which cover huge areas throughout the region. The IPCC observes that increased rainfall during the northeast monsoon and increased severity of extreme rainfall events (both predicted with climate change) are expected to 'increase the frequency and intensity of flooding within the region'.

The IPCC also states that 'The impacts of climate change on coastal areas in tropical Asia could be severe and in some areas catastrophic'. Heavily populated and intensively used low-lying coastal deltas, plains and islands are most at risk from sea-level rise in the form of coastal erosion, land loss, flooding and salt water intrusion. The large deltaic regions of Bangladesh, Burma, Thailand and Vietnam, and low-lying regions of Indonesia, the Philippines and Malaysia are especially vulnerable. Indeed, assuming no change in population and no adaptation, a 1 metre sea-level rise 'could displace nearly 15 million, 7 million, and at least 2 million people from their homes in Bangladesh, India and Indonesia' and threaten millions more in other regions. Land loss is one of the most serious coastal issues for the region. A 1 metre sea-level rise could lead to 'land loss in Bangladesh, India, Indonesia, and Malaysia of nearly 30,000; 6,000; 34,000; and 7,000 km² respectively'. Sea- level rise and heavy rainfall would also impact the region's agriculture (due to inundation, salinisation and land loss), coastal aquaculture and coastal tourism.

The Ganges-Brahmaputra delta is extremely densely populated, and subsidence combined with sea-level rise could cause sedimentation and drainage problems as well as coastal erosion and land loss. Higher sea levels could also mean more areas affected by cyclonic surge, and inland ponds, lakes and aquifiers affected by saline water intrusion.

The impacts of sea-level rise are expected to be great for Asia's island states, especially the atolls of the South Pacific, where, as the United Nations Environment Programme (UNEP) observes, 'increased frequency and severity of tropical cyclones, coastal inundation and flooding as well as saltwater contamination of drinking water supplies could have profound consequences for agriculture, forestry, coastal development and human health'.[79]

Temperate Asia

Temperate Asia experiences annual tropical cyclones, which intensify flood situations in coastal regions. There is a lack of conclusive evidence as to whether the frequency or intensity of these cyclones would alter with climate change. However, as the IPCC observes, '…with the projected sea-level rise, even if the frequency and severity of storms remain unchanged in the future, storm surge could still present an increased hazard'.

Global warming can also affect stream hydrology - in a variety of ways. In humid regions, rivers and streams are expected to experience reduced total rainfall and/or higher evapotranspiration rates (producing longer droughts) but in semi-arid regions they could experience increased hydrological variability with longer droughts and 'more frequent and larger floods with high sediment loads'.

In summary, tropical and temperate Asia have the most coastline of all the world's regions, and their rich marine resources have been central to their development. In many parts of Asia economic development has been greatest in coastal zones, and this has put coastal

ecosystems under enormous pressure. Climate change, then, is expected to increase this pressure and a reassessment of present and future coastal developments may be required.

Arid Asia

All areas in this region experience wide rainfall fluctuations, and animals and plants can cope with sequences of extreme climatic conditions. The IPCC states, 'Although precipitation is projected by some models to increase slightly, this increase will have little impact because most of the region will remain arid'. As for coastal systems, no scenarios suggest that the region's coastal zones will be significantly affected by changes in sea level (the IPCC observes that major pressures on these zones will be development related rather than as a result of climate change).

Water resources and drought

Climate change is likely to lead to an acceleration of the hydrological cycle, producing a greater level of both precipitation and evaporation. Overall, this acceleration will result in a wetter world.[80] (Models predict that global precipitation could increase by 7-15% and evaporation by 5-10%).[81] However, not all regions will benefit from increased rainfall; models predict that precipitation will increase at high latitudes (which are already generally wetter), but decrease at low and mid latitudes creating a risk of more severe, longer lasting droughts in these areas.[82]

This potential increase in droughts as a result of global warming is a great concern considering that the world's water resources are already under significant stress. Water use has risen dramatically in the past 100 years, and approximately 1.7 billion of the world's population now live in countries that are water-stressed (meaning that use of their renewable water supply is more than 20%).[83] It is estimated that by 2025, depending on the rate of population growth, this number will increase to 5 billion.[84]

The IPCC observe that 'Water resources are inextricably linked with climate, so the prospect of global climate change has serious implications for water resources and regional development'.[85] The IPCC predicts that as a result of global warming there will be an increased risk of drought during the 21st century over most mid-latitude continental interiors including drought occurring with El Nino events in many different regions.[86] It also predicts that climate change will lead to 'decreased water availability for populations in many water-scarce regions, particularly in the sub-tropics'.[87] (Not only will water become scarcer, but the quality of available water will deteriorate.) Climate change, therefore, is likely to compound existing and future water pressures and intensify competition for water resources.

Regional Predictions

Regional predictions about water resources and drought are as follows:[88]

Latin America

Approximately two thirds of Latin America is arid or semi-arid. This includes large parts of Argentina, Bolivia, Chile, Peru, Brazil, Ecuador, Colombia, and Mexico.[89] Although Latin America has around 35% of the world's fresh waters, water distribution among and within countries varies greatly and many areas, such as north-eastern Brazil, northern Chile and coastal Peru struggle to meet their populations' water requirements. Moreover, demand for water is rapidly increasing due to the growth of populations, industrial activity and irrigated agriculture.[90]

Latin America's freshwater systems are extremely important: the development of thousands of human settlements, industrial and agricultural activities including fisheries and aquaculture, tourism and energy production have all been facilitated by lakes, reservoirs, river basins and freshwater wetlands. Moreover, the region's freshwater areas host a large number of fish and animal species which provide an important source of income for local communities. Yet freshwater systems are potentially highly sensitive to climate change and climate fluctuations, and it is expected that droughts (as well as flash floods) associated with climate change would reduce their productivity and biological diversity. However, in order to determine in more detail the effect that increased climatic variability may have on the productivity of freshwater systems, adequate meteorological and hydrological observation networks need to be established. These are currently lacking in most Latin American countries.

Rangelands are also susceptible to drought. They cover 33% of Latin America and sustain commercial ranching, subsistence farming and pastoralist activities; indeed, 80% of the region's animals feed off them. Yet the productivity of rangelands is directly related to amount and distribution of precipitation. Temperate grasslands in particular are vulnerable to drought: if climate change brought increased rates of evapotranspiration and higher temperatures, livestock production could be negatively affected. However, experience has revealed that the biggest threat to Latin America's rangelands comes from extreme events such as large-scale floods, and drought-erosion cycles. It is important to note that when analysing the effect of climate change on rangelands, the IPCC observes that human activities could cause more damage to them than global warming. In Argentine Patagonia, for example, unsustainable numbers of sheep have led to pastureland changes and even desertification.

Finally, drought in rural areas could lead to increased water problems in urban areas. Large groups of people in Latin America are already migrating from drought-prone rural areas to modern cities, and this urban migration trend will put water resources under even greater stress, generating difficulties in providing good quality drinking water to urban dwellers. Indeed, according to UNEP, there will be a threefold increase in urban populations in Latin America and a fivefold increase in domestic demand for water.[91]

Africa

Africa is already persistently afflicted by extensive drought: local droughts occur every year and continental crises appear to occur once a decade (or more recently, twice). Indeed, although the continent of Africa uses only around 4% of its renewable freshwater resources, 'water is becoming one of the most critical natural resource issues'.[92] Currently around two thirds of the rural population and a quarter of the urban population lack access to safe drinking water, and the number of people suffering from water stress or scarcity is rapidly increasing as a result of population growth, urbanisation, and increased economic development.[93] According to UNEP, currently '14 countries in Africa are subject to water stress or water scarcity' and 'A further 11 countries will join them in the next 25 years'.[94]

Climate change is expected to intensify Africa's increasingly critical water situation, with southern Africa being one of many water stressed regions in which climate change could further decrease stream flow and groundwater recharge.[95] Reduced annual average rainfall and run off would also exacerbate desertification in southern Africa.[96] Africa relies on water for its social, economic and environmental well-being, so prolonged drought is the most serious climate related hazard for the continent. Drought events in southern Africa in the early 1990s have demonstrated the sub-region's sensitivity to climate variation. The drought was disastrous for many rural communities in the sub region where grain production fell 60% below expected levels. Indeed, five times more food had to be delivered to southern Africa than had been brought into the Horn of Africa in the 1984-1985 famine, and 11 countries had to help alleviate the crisis. Post drought recovery was slow.

Although the IPCC states that the 'potential effect of climate change on drought in Africa is uncertain', it also asserts that 'It seems prudent to expect drought in Africa to continue to be a major climatic hazard', observing that even a small decrease in precipitation combined with higher evapotranspiration could result in 'significantly greater drought risks'. Consequently, the IPCC recommends the improvement of water use and irrigation systems in Africa (which would also benefit the region regardless of climate change).

Asia

Asia has a poor safe water supply record, with one in three Asians lacking access to a safe water source within 200 metres of their home.[97] Although water availability varies greatly

within Asia, it is possible to state that the region's water resources 'are under increasing pressure'.[98] Some arid countries such as Iran and Afghanistan are already suffering chronic water shortages, and most developing countries in the region are experiencing increasing water scarcity, water quality deterioration and conflicts over water allocation. This situation is expected to worsen, with demand for water increasing throughout the region in this century; it is expected that India will be water stressed by 2025 and China before that.[99] Another major issue is water quality, which has been steadily degraded by several factors including sewage/industrial effluent, agricultural and urban run-off and saline intrusion. UNEP observes that water quality 'is one of the most pressing environmental problems in many parts of the region', and contamination will reduce per capita water availability in the future.[100]

Rising global temperatures, therefore, are likely to intensify Asia's water shortages. With reference to tropical Asia, the IPCC states that the impact of climate change on the region's water resources could be significant, with increased evaporation and changes in precipitation affecting frequency and intensity of droughts, soil moisture, and water for irrigation and hydroelectricity. Although the IPCC admits to uncertainties over the impact of global warming on water resources in temperate Asia, it reveals that increased levels of $_{CO2}$ show a 'decrease in water supplies throughout Temperate Asia, except in a few river basins'. As for arid Asia, due to rapid development and expanding populations water in the region is already a scarce resource. Although the IPCC observes that 'Projections of changes in runoff and water supply under climate change scenarios vary', it also states that water shortages are 'unlikely to be reduced and may be exacerbated' by climate change.

Food Security

Drought has multiple effects - it affects not only water resources, but also agriculture and subsequently food security. The effect of climate change and drought on agriculture and food security will have serious implications for sustainable development.

Food security means the ability of people to grow or obtain food. Food shortages in developing countries lead to malnutrition and death. According to the UN Food and Agriculture Organisation (FAO), 841 million people in developing countries already suffer from basic-protein malnutrition. Malnutrition can stunt physical and mental development in children, cause low productivity in adults, and increase susceptibility to infectious diseases. Therefore, food security is crucial to sustainable development.

Food security in developing countries is already threatened by trade, population growth, human-induced deforestation, and desertification. Climate change is another factor threatening the ability of people to obtain food. While some agricultural regions such as Northern Canada and Europe may benefit from global warming, it is predicted that tropical and sub-tropical regions will experience a reduction in crop yields with any increase in temperature.[101] Those dependent on isolated agricultural systems in arid and semi-arid regions face the greatest risk of food insecurity.

It is expected that average temperatures will rise more near the North and South poles than the equator, making the shift in climate zones more pronounced at higher latitudes than mid latitudes. Temperature zones in mid-latitude regions could shift by 150 – 550 km.[102] As each latitudinal belt is currently optimal for particular crops, climatic shifts could have a strong effect on agricultural and livestock production.[103]

The following regional predictions have been made for Latin America, Africa and Asia:[104]

Latin America

Agriculture in Latin America is a key sector in the region's economy, occupying 30-40% of the economically active population. Furthermore, in those countries lacking oil and mineral production, agriculture has provided the largest export income. Agriculture is also the basis of subsistence lifestyles in the region's smaller and poorer countries. Nevertheless, land degradation in the subcontinent is a major problem. Around 72.7% of South America's agricultural drylands suffer from moderate to extreme deterioration, and about 47% of grazing lands have lost their fertility. 63 million hectares of land are affected by degradation in Central America.[105] Total annual losses from drought and desertification in Latin America may exceed $4,800 million, and it would cost $13,000 million to restore degraded land.[106]

Climate change, therefore, could worsen the already extremely serious land degradation problem in Latin America, affecting food production and endangering food security. According to the IPCC, agricultural production in *lower latitude* and *lower income* countries is more likely to be affected negatively by climate change.[107] Therefore large numbers of Latin American communities would be vulnerable to global warming through reduced rainfall impacting yield. Decreases in production are expected for major crops in Mexico, Brazil, Chile, Argentina, Uruguay, and Central American countries. This could have devastating consequences: in Mexico, for example, more than one third of the population works in the agricultural sector, which is critical to the nation's economy. Agricultural production is already stressed by low and variable rainfall and, as the IPCC observes, 'any shift toward warmer, drier conditions could bring nutritional and economic disaster'.

Latin America's oceans are also extremely important economically (marine resources include fish, shellfish and crustaceans, seaweed and marine mammals). During the period 1985-1987, the annual average catch of fish by Latin American countries was about 17% of the world's catch, and Latin America has developed 'some of the most important saltwater fisheries in the world'. Yet climate change could have a damaging effect on the subcontinent's fishing industry. Combined with over fishing, climate change would, the IPCC predicts, 'reduce fish quality and stocks in Latin American seas, increasing the vulnerability of the fishing industry - particularly on regional seas plied by countries outside the region'. Having established this, however, the IPCC also observes that human activities

such as over-fishing, pollution of coastal oceans and estuaries, and habitat destruction are having a far more destructive effect on marine fisheries than any impact expected from climate change. Finally, and as mentioned above, livestock production in Latin America could also be reduced by higher temperatures and less rainfall affecting grasslands.

Africa

African economies are very dependent on agriculture: one third of Africa's land area is permanent pasture and arable land, and agriculture accounts for 30% of GDP. Almost three quarters of the population of Africa live in rural areas and almost all of the rural labour force works in the agricultural sector (livestock, forestry and fisheries). However, much of Africa's land is of poor quality and the continent is particularly vulnerable to food insecurity; indeed, Africa receives the largest amount of food aid in the world. Moreover, according to UNEP, 'crop yields would be cut by half within 40 years if the degradation of cultivated lands were to continue at present rates'.[108]

The impact of global warming on food production in Africa, including southern Africa, is uncertain. The IPCC make the observation that climate change 'will affect some parts of Africa negatively' and 'enhance prospects for crop production in other areas'. Increased CO_2 can increase yields, and the World Wide Fund for Nature (WWF) predicts that that this may be the case for southern Africa.[109] However, the IPCC observes that the effect of CO_2 on African crops is uncertain, and although CO_2 can increase crop yield, this benefit may be outweighed by the adverse effects of heat and drought. If droughts become more common, widespread and persistent as a result of intensified global warming, 'many sub-humid and semi-arid regions will have difficulty sustaining viable agricultural systems'. This implicates Africa, where precipitation (as opposed to flooding and storms) is the most important climatic element affecting food production. Africa's staple crops are cereals, particularly maize, and as most of these crops are rain fed as opposed to irrigated, their yields are very sensitive to climatic variations. Moreover, pastoralism is common in the continent's semi-arid regions, and, relying on grass and browse, this is also sensitive to long periods of drought.

Climate change and reduced rainfall, then, has the potential to seriously impact Africa's food production. The IPCC concludes: 'It is established, though incompletely, that climate change, mainly through increased extremes and temporal/spatial shifts, will worsen food security in Africa'.[110] The importance of precipitation to agricultural productivity is demonstrated by a period of drought that occurred in the Sahel and east and southern Africa between 1970 and 1995. In 1991 and 1992, cereal production in the Southern African Development Community region was almost halved as a result of drought, and around 20 out of 85 million people suffered food shortages.[111] Zimbabwe was forced to import 800,000 tonnes of maize, 250,000 tonnes of wheat and 200,000 tonnes of sugar to make up the shortfall caused by reduced rainfall. Worryingly, UNEP states that recurrent droughts in southern Africa 'are expected to continue to lower yields for another decade or more'.[112]

Asia

There is less land per person in the Asia-Pacific region than in other regions of the world, and improving (or even maintaining) the situation is becoming harder as populations continue to grow and urban and industrial infrastructure destroys agricultural land.[113] The increasing shortage of agricultural land has been somewhat offset by improvements in agricultural yields (food production in Southeast Asia grew faster than in any other part of the world between 1980 and 1990). However, food production in the last decade has not equalled that of previous decades.[114] Moreover, a combination of factors including deforestation and unsustainable agriculture has had a 'devastating impact on land resources' in the region.[115] Around 20% of its total vegetated land is affected by soil degradation, which in dry areas substantially reduces agricultural production. As UNEP states, 'Soil erosion has reduced agricultural potential in many countries'.[116] As for the future, UNEP observes that 'The limiting factor to producing more food in the future will be freshwater supplies. In Southeast Asia, there is already little potential for additional large-scale water development schemes'.[117]

The IPCC assesses the impact of climate change on Asia's food production, particularly rice which is of great importance to the region. With reference to both temperate and tropical Asia it details how in some areas the effects on rice yield are expected to be positive and in others, negative. The uncertainty of the effect of climate change on crop production is revealed by the fact that the IPCC projects a yield change for China's rice of –78% to +15% by 2050. If rice production was negatively impacted as a result of global warming, this would, as the IPCC state, '…be of concern in the face of expected population increases'.

Agriculture is key to tropical Asia's economy and employs over half of the labour force. Yet the IPCC predicts that in many areas 'changes in average climate conditions and climate variability will have a significant effect on agriculture' (adding that especially vulnerable will be low-income populations relying on isolated agricultural systems). This is a concern, especially with population growth adding extra stress on food production. Indeed, each hectare of cropland supports a large human population, and it has been estimated that 'per-hectare rice yields will need to be doubled by 2025 to meet demand'. Tropical Asia's agriculture is also vulnerable in that a significant amount of it relies on rain, which may be affected by global warming. Finally, the IPCC observes that agricultural areas in the region are vulnerable to frequent floods, droughts, storm surges and cyclones that, apart from destroying life and property, can 'severely reduce agricultural production'. Bangladesh, for example, between 1962 and 1988, lost around half a million tonnes of rice every year as a result of floods.

As for fish production (in temperate Asia), the IPCC states that with global warming the positive effects on saltwater fisheries (for example longer growing seasons and lower winter mortality) 'may be offset by negative factors' such as changes in reproductive patterns and

ecosystem relationships. Gains or losses in *freshwater* fisheries for different regions will depend on changes in precipitation and temperatures.

Health

Global warming is expected to expose millions of people to new health risks. The most vulnerable to ill-health are those communities living in poverty, those with a high incidence of under nutrition, and those with a high level of exposure to infectious diseases.[118]

Heat and Cold

Climate change directly impacts human health through causing heat waves. Studies on temperate and sub tropical countries have revealed that daily death rates have risen with extreme outdoor temperatures.[119] With climate change expected to increase the number of days with higher-than-normal maximum temperatures, morbidity and mortality would increase.[120] Heat related deaths will be partially offset by a reduction in the number of cold related deaths.

Disease

Citizens of tropical and sub-tropical environments are already exposed to a number of parasitic and infectious diseases. Global warming is expected to aggravate the transmission of such diseases, extending their area of influence or intensifying outbreaks.[121]

Vector-borne diseases

With global warming, conditions would become more favourable for vectors, and vector-borne diseases including malaria, dengue, yellow fever, chagas disease, schistosomiasis, river blindness, and leishmaniasis could expand their elevational and geographic ranges.[122] The IPCC states, for example, that heavy, monsoon-like rains and higher temperatures will favour the breeding of disease carrying mosquitoes, which will be able to thrive at higher altitudes.[123] Malaria cases in the Rwandan highlands of Africa have already increased by 337% in recent years, with 80% of this increase being linked to temperature and rainfall change. There has also been a similar link reported in Zimbabwe.[124] Increased incidence of vector-borne diseases including malaria is a risk facing all the three regions, where these diseases are already causing morbidity and mortality.[125] WWF has predicted that by the year 2050 up to 1 million additional deaths from malaria may be occurring annually as a result of climate change.[126]

The effect of extreme events

The World Health Organisation defines health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'.[127] Much of this 'well-being' depends upon the welfare of the community. As extreme weather events increase, poverty will be exacerbated, community welfare affected, and consequently ill-health is likely to increase. Extreme events such as storms, floods and droughts also impact human health through increasing pathology rates. This is either directly through injuries, or indirectly through infectious diseases caused by community dislocation, lack of water and other stresses.[128]

Floods

The World Health Organisation observes that floods pose the biggest threat to health, having longer lasting and more far-reaching effects on their victims than other climate-related disasters.[129] Floods increase the number of people exposed to water-borne diseases such as cholera, diarrhoeas and dysenteries, as the poor are forced to drink contaminated water when fleeing them; sanitation, storm-water drainage and sewage disposal systems are often disrupted, and flooded displaced communities, especially those with limited resources, are more likely to contract infectious diseases and spread them to new areas. Moreover, as the IPCC observes, 'Viral, bacterial and protozoan agents of diarrhoea can survive in water - especially in warmer waters - for long periods of time and thus spread at increased rates in rainfall periods…'.[130]

There are many examples of how floods have impacted human health:

- In October 1999, in Achuapa, Nicaragua, almost 2,500 people became ill with leptospirosis (a disease spread by rats) following heavy rains and flooding.
- A month after Hurricane Mitch hit Central America in 1998, PAHO reported 2,700 cases of Malaria in Nicaragua and 1,900 cases in Honduras, 1,400 suspected cases of cholera in Guatemala, and 1,200 cases of dengue fever in Honduras and Nicaragua.[131]
- During the 1997-1998 El Nino, excessive flooding caused epidemics of cholera in Djibouti, Somalia, Kenya, Tanzania and Mozambique.

Droughts

Drought can also impact health. As water resources become scarcer and competition for water increases, polluted water may be used for drinking and bathing, and this spreads infectious diseases such as typhoid, cholera and gastroenteritis. These diseases particularly affect the urban poor. Moreover, decreased availability of water for irrigation and food production heightens the risk of poor nutrition and increased susceptibility to disease.[132]

The implications of climate change for health are numerous and wide ranging. For example, climate change is expected to warm the oceans, which may cause temperature-sensitive toxins produced by phytoplankton to contaminate seafood and increase the incidence of food poisoning.[133] The long list of potential health effects is deeply concerning, and precipitates the need for, among other things, improved medical care services in developing countries.

Forestry

Observations and experiments demonstrate that an increase of just 1ºC in global average temperature would affect the composition and functioning of forests.[134] With climate change predictions as they stand, there would be a major impact on the species composition of around a third of the world's forests. New species combinations, and hence new eco-systems, may be established while entire forest types could disappear.[135] With global warming forests could also be affected by more pests, more pathogens and more fires. Boreal forests (forests of northern and mountainous parts of the Northern hemisphere) are expected to be affected more than temperate and tropical forests, as higher latitudes are expected to warm more than equatorial ones.[136]

The following regional impacts of climate change on forestry have been predicted:[137]

Latin America

Latin American forests cover approximately 22% of the region, and are an important resource. They provide commercial products for national and international markets, sustain the livelihoods of indigenous people, house a large share of the world's plant and animal species, and have a strong influence on regional and local climate. Yet deforestation in the region is a major problem: the annual average rate of deforestation increased from 5.4 million ha in 1970 to 7.4 million in 1990, with Brazil alone losing approximately 15 million ha of forest area between 1988 and 1997.[138] The primary causes of deforestation in Latin America are mining, the construction of new roads and settlements, and the expansion of the agricultural frontier. Two other factors threatening the forests are logging and drought-induced forest fires. In the future, wood harvesting and forest clearing for agricultural land is expected to increase.[139]

Climate change, as vulnerability studies have revealed, poses a further threat to the existence of Latin America's forests, particularly through increasing the incidence of forest fires. In the last 20 years, Amazonia has experienced several abnormally intense dry seasons, and during these periods 'the burning was far worse than normal'.[140] This fact is supported by UNEP, which observes that 'Severe seasonal droughts associated with *El Nino* events…are increasing the flammability of large areas of forest in the Amazon

region'.[141] Forest fires are causing significant losses to Central American economies. In 1988, for example, drought combined with slash-and-burn agriculture caused large forest fires in the Amazon, and 1 million ha of forest was lost. The UN estimated losses to be 100 rural houses, 14,000 cattle and 700 silos, affecting 12,000 people (including 7,000 indigenous peoples).[142]

According to the IPCC, further loss of Latin America's forests through large-scale deforestation or drought induced fires could have a very negative impact on precipitation. Researchers estimate that much of the Amazon's rainfall is created by water vapour produced from the forest.[143] Continued human or climate induced deforestation of the Amazon rainforest, then, could reduce rainfall and subsequently runoff in areas within and well beyond the basin, having far-reaching negative effects. Reduced precipitation would also make the region significantly drier, causing it to be more vulnerable to forest fires.[144] Thus climate change could precipitate a vicious cycle of deforestation and drying.

Finally, all forests act as 'carbon sinks', which means they take CO_2 out of the atmosphere and store it. Latin America's tropical forests have great carbon sink potential. However, when forests are destroyed or burned they release large quantities of carbon dioxide into the atmosphere, for mortality emits carbon faster than growth can absorb it. Destruction of Latin America's forests by humans or drought induced fires, then, could intensify global warming through raising CO_2 levels.

Africa

African forests cover 520 million hectares (mainly concentrated in tropical zones of western and central, and eastern and southern Africa) and make up over 17% of global forests.[145] In many African countries, forests are economically very important and across the continent they provide 6% of GDP - the highest percentage in the world. Moreover, around 90% of Africans rely on firewood for their energy requirements.[146] Yet like Latin America, Africa's forests also suffer from deforestation as a result of, amongst other factors, the expansion of agriculture, commercial harvesting, and heavy livestock grazing. In the 1980s Africa lost 47 million hectares of forest, had lost a further 19 million by 1995, and UNEP predicts, 'The pressures on African forests will inevitably continue rising to meet the needs of fast-growing populations in rapidly urbanizing and industrializing countries…'.[147]

Climate change is expected to add further stress to this already deteriorating situation. The IPCC states that, for Africa, 'A sustained increase in mean ambient temperatures beyond 1ºC would cause significant changes in forest and rangeland cover'. As Africa's forests are socio-economically very important, protecting water resources and providing timber, fuel and other non-wood products, the IPCC's observations should be taken into consideration in the continent's development plans.

Asia

Primary forests in Asia have been significantly depleted, largely as a result of clearing for agriculture and cutting for timber. Forest fires have also had a major impact (from September 1997, fires in Indonesia burned for several months and destroyed around 1 million hectares).[148] In 1995, Asia and the Pacific's average per capita forest cover was significantly lower than the world average, and though there are in-region variations, the 'forests that remained in 1995 seem incapable of satisfying the needs of the population'.[149] In the Philippines, Thailand and South Asia particularly, shortages of domestic wood are appearing. As for the future, Asia's dominance in the global trade of tropical hardwoods is 'likely to decline. At current rates of harvesting, remaining timber reserves in Asia will last for fewer than 40 years'.[150]

Studies on the regional impacts of climate change on the forests of tropical Asia are limited. However, research undertaken in Thailand, for example, has revealed that climate change would have a 'profound effect on the future distribution, productivity, and health' of the country's forests. As for Asia's *temperate* forests, the IPCC states that '…global warming can be considered sufficient to trigger structural changes' in those that remain. Further research would prove useful in predicting what climate change effects would be for each region's different forest types.

Finally, the IPCC makes the observation that forest fires induced by variations in climate such as longer dry seasons are a danger for Asia's forests, affecting their composition and age diversity. Also, and as stated with reference to Latin America, deforestation, whether human or climate induced, causes reduced precipitation and drying. This can have a serious impact on food production. In peninsular Malaysia, for example, 'the drying has been severe enough to force the abandonment of some 20,000 hectares of rice paddy'.[151]

In summary, forests are highly sensitive to climate change but also to other stresses such as land use change. With reference to tropical forests, the IPCC states that they are 'likely to be more affected by changes in land use than by climate change, as long as deforestation continues at its current high rate'. This statement reveals the need to address the problem of global warming *and* human induced deforestation.

Biodiversity

The extinction of plant and animal species is accelerating. 11% of the world's species of birds, 25% of its species of mammal, and around 34% of its fish species are vulnerable or in 'immediate danger of extinction'.[152] Factors contributing to this loss of biodiversity include habitat destruction, over-harvesting and pollution. Wildlife and eco-systems are also susceptible to climate change: rising temperatures and pollution can cause habitat alteration and the further decimation of plant and animal species. (Non-tidal wetlands, for example, provide refuge and breeding grounds for many species yet wetlands are threatened by higher rates of evaporation.)[153] The IPCC predicts, 'While some species may increase in

abundance or range, climate change will increase existing risks of extinction of some more vulnerable species and loss of biodiversity'.[154]

As increasing numbers of species disappear, ecosystems start to collapse and '…at some point, we will face wholesale ecosystem collapse'.[155] Loss of biodiversity is a serious concern especially in the developing world, where rural livelihoods and health may depend on the resources available in diverse species of plants and animals. For example, farmers rely on wild plants for cultivation and cross pollination, and also on natural predators to reduce crop damage by pests. In addition, wild plants supplement the diets of the rural poor in developing countries. Plants and animals also provide much of the material needs of the very poor, such as fuel and shelter, and many societies are reliant on plant and sometimes animal extracts for their medicines. In summary, the preservation of biodiversity is vital for the lives of many in developing countries, and therefore the impact of climate change on biodiversity has serious implications for sustainable development.

It is also important to assess how any loss or reduction in the quality of wildlife and biodiversity may affect the tourist industry, which provides an important source of income for many regions. The impact of climate change (including biodiversity loss) on tourism is covered in the next section.

Section 3: Wider Climate Change Implications

Climate change has multiple implications for sustainable development. Other important possible impacts to consider are as follows:

Social Costs

Drought and desertification have social costs. The IPCC states: 'Increasing aridity and prolonged spells of severe drought could accelerate abandonment of the rural economy and migration to urban centers'.[156] As millions of people move from the countryside to the city to escape the effects of drought, they perpetuate and aggravate urban poverty. In Latin America large numbers of people are already migrating internally and regionally from drought-prone rural areas to modern cities. Such displacement is likely to have serious socio-economic and health implications.

Being forced to migrate is also highly stressful and unsettling for communities. Remote communities living above the Arctic Circle that have lived all their lives in one area or on one island are currently having to face up to the possibility of relocation, as rising temperatures are making sea-ice unstable and more aggressive wave action is eroding the land.[157] Those living in developed countries may underestimate how important land is to such islanders – and the 'deep personal and cultural significance of its loss'.[158]

Conflict

Countries may find themselves in conflict over increasingly scarce food and water supplies. As the IFRC states, 'environmental changes raise the risks of 'resource wars' as nations and communities fight for rights to key resources…'.[159] India and Pakistan, for example, have a treaty which agrees the division of the waters of the River Indus. If the climatologists who suggest that the river could lose 40% of its flow in this century are proved right, could the agreement - and peace – be maintained?[160]

Climate change may also lead to instability within countries and across international boundaries as sea-level rise, deforestation and severe drought creates millions of environmental refugees. With a 50 cm sea-level rise, refugees could number 92 million, and '118 million with a one metre rise'.[161] These refugees will need to subsist somewhere, and this could create further tension and conflict over environmental resources. Indeed, UNEP includes 'refugee flight from environmental wastelands' as a situation that could escalate into violence and even cause armed conflict.[162]

Economic Costs

Unless the trends of rising global temperatures and continued environmental destruction can be reversed they '…almost certainly will lead to economic decline'.[163] Some of the ways in which climate change will affect the economy are outlined below.

- The sensitivity of industry, energy and transport to climate change is low when compared with that of natural ecosystems. However, renewable energy production; construction; infrastructure located in vulnerable areas and some transport systems are sensitive to sudden changes and extreme events. Coastal industry, infrastructure and ports would be affected by rising sea-levels.[164]

- Another sector vulnerable to disasters is property insurance; the insurance industry has, in recent years, witnessed a significant rise in weather related losses.[165] A higher risk of extreme events could precipitate higher insurance premiums or the removal of insurance coverage in some areas.

- Some countries' GDP is severely affected as a result of natural disasters. Cyclones that struck Samoa in 1990 and 1991, for example, caused an estimated total loss of $416 million dollars, which was four times the country's GDP.[166]

- Global economic losses from climate related disasters are rising fast. Reported economic losses have risen from $131 billion in the 1970s to $629 billion in the 1990s (actual losses are even greater).[167] It is estimated that the cost of disasters over the next 20 years will be from US$6 to 10 trillion - ten times predicted aid flows.[168] It has even been projected that 'the upward curve of economic damage from global warming will overtake gross world product by 2065, effectively bankrupting the global economy', with 'serious destabilisation' likely long before that date.[169]

Tourism

Another important economic sector that will be affected by climate change is tourism. The IPCC states, 'Significant extinctions of plant and animal species are projected and would impact…tourism'.[170] Outlined below are the predicted impacts of global warming on the tourist industries within Africa, Latin America and Asia.[171]

Latin America

The IPCC has predicted the following:

- Latin America's freshwater systems provide an important source of income for the region from tourism (its tropical rivers are very attractive to tourists, being home to around 1,500 species). These systems are highly sensitive to climate change, and any damage to them could negatively affect the tourist industry

- Warming in the mountain regions of Latin America could modify snowfall rates and cause the disappearance of snow and ice, which could affect tourist activities such as mountain sports. Glaciers in the Venezuelan and Peruvian Andes are already melting at an accelerated rate

- Tourism could be impacted by sea-level rise resulting in land loss from tourist resorts. In Uruguay, for example, where the national tourist industry brings in $200 million and attracts more than a million people every year, land lost as a result of climate change may be small but the capital risk would be very high

Africa

While tourism is one of Africa's fastest growing and most promising industries, it is dependent on wildlife and water (for recreation), so the industry would be significantly impacted by a loss of these attractions. According to the IPCC, the greatest impacts on tourism are likely to be felt in drought-prone parts of the Sahel, east Africa, and southern Africa.

Climate change poses a serious threat over the coming decades to Africa's wildlife and eco-systems, including a likely change in habitat type for large nature reserves in Southern Africa including the Kruger National Park, the Zambesi basin and the Okavango delta.[172] These changes could be damaging for many species of animals and birds and consequently the tourist industry.

Africa's tourism could also be affected by river flow changes, reduced water run off and drying of reservoirs, especially in eastern and southern Africa where water based activities such as sailing, rafting and angling are popular. Many tourist hotels have been built near reservoirs and lakes (e.g. Lake Malawi, Lake Chad and Lake Victoria) and, as the IPCC states, 'Past drought episodes have demonstrated that fluctuations in lake levels affect the quality of services that the lakeside resorts offer'. Reduced water run off could also alter the characteristics of popular tourist destinations. In the period of drought in 1992, for example, Victoria Falls suffered greatly reduced water discharge and consequently became less attractive to tourists.

Finally, tourism in Africa could also be affected by the destruction of coastal zones and marine eco-systems, which are important attractions in Kenya and Tanzania especially.

Asia

Asia possesses the world's highest mountain range (the Himalayas), the second biggest rain forest complex and over half the world's share of coral reefs. China, Indonesia and Malaysia are ranked among the world's top countries for biodiversity.[173] With climate change expected to impact biodiversity, mountain and coastal ecosystems and coral reefs, tourism in Asia is also likely to be affected. The following are some examples of the kinds of ways in which tourism could be impacted:

- The disappearance of sandy beaches in Southeast Asia as a result of sea-level rise would undermine tourism in this region which currently provides an important source of income

- Global warming is already affecting snow and ice cover in the tourist-popular Himalayas, with recent evidence revealing a three mile retreat of the Everest glacier[174]

- The effect of sea-level rise on the small island states is predicted to have the most serious impact on tourism. In the Maldives, for example, where tourism is the backbone of the islands' economy, with rising sea-levels there will be at best coastal erosion and at worst proportions of land becoming uninhabitable

- Coral reefs provide an important source of income from tourists yet they are vulnerable to 'bleaching' (death of the coral caused by higher sea temperatures). In the last 2 years, record sea temperatures have destroyed 70% of the coral in the Indian Ocean.[175]

In summary, then, as climate change poses a significant threat to the tourist industry, it is crucial that regions relying on income from tourism consider this threat and the impact it may have on their economy.

Section 4: Climate Change Mitigation and Adaptation

Climate change mitigation processes

The current rate of economic growth that the world is experiencing is outgrowing the capacity of the earth's ecosystems to contain it. The correlation between increased production and consumption and climate change reveals that the economic development of Northern countries in particular is proving to be environmentally unsustainable. These countries have been responsible for the majority of fossil fuel use in the last 200 years, and while reaping the benefits of industrialisation they have contributed heavily to global warming. Developing countries have contributed the least to global warming yet they suffer most from its effects. Therefore, logic and moral duty suggests that rich, industrialised nations should be the first to address their patterns of trade, production and consumption and take the lead in reducing greenhouse gas emissions. One way in which Northern governments are accepting and attempting to address their responsibility for global warming is through the Kyoto Protocol.

The Kyoto Protocol

The adoption of the UN Framework Convention on Climate Change (UNFCCC) in 1992 was the first step taken by governments to tackle the problem of global warming. The Convention was initiated after the IPCC's First Assessment Report - presented in 1990 - confirmed that climate change was a reality and potentially a very serious problem. [176] Having accepted the IPCC's findings almost all countries signed the UNFCCC at the Rio 'Earth Summit' in 1992 and subsequently ratified it.

The objective of the Convention is to ultimately stabilise emissions of greenhouse gases at a level that would prevent 'dangerous anthropogenic interference' with the world's climate.[177] The Kyoto Protocol, adopted in 1997 and signed by 186 countries in 2001, was a follow up to the Convention and established the long-term structure for global participation in emissions cuts. It defined emission targets for industrialised countries for an initial period of 2008 – 2012, committing them to reduce their greenhouse gas emissions from 5 – 8% below their 1990 levels within this period.[178] The Protocol included a requirement that negotiations for a second period must begin by 2005. The emissions reduction demanded by the Kyoto Protocol is far below the level of cuts required to prevent 'dangerous interference' with global climate. The IPCC estimates that for this, 60-80% cuts would be necessary. However, the Protocol carries in-built mechanisms that allow for stronger action in the future as well as the inclusion of developing countries.[179]

Flexible Mechanisms

The Protocol includes three mechanisms through which Parties can offset their carbon dioxide emissions. These are Joint Implementation (JI), Emissions Trading and the Clean Development Mechanism (CDM). JI means that countries can claim credit for emission reductions arising from investments – for example in low-emissions technology - in other industrialised countries. Emissions trading allows countries that reduce emissions more than is required by their specified target to sell excess emissions credits to countries that struggle to meet their own target. Both JI and emissions trading reduce pressure on industrialised nations to make domestic cuts. The CDM gives developed countries credit for financing projects which reduce or avoid emissions in developing countries. While JI and emissions trading, '…shift around the pieces of the industrialised countries' overall 5% target'[180] the CDM reduces emissions in developing countries which have no targets, and as credits gained by investing in CDM projects enable industrialised countries to avoid domestic emissions reductions, the CDM is, at best, globally carbon-neutral.[181] The main advantage of the CDM is that through encouraging the transfer of clean technology, it enhances developing country capacity to make the transition to cleaner production, and as such it promotes sustainable development.

The argument for including these three mechanisms in the Kyoto Protocol was that they would allow countries to cut their emissions in the cheapest ways possible and so reduce the cost of compliance, as well as stimulate international investment and support cleaner economic transition and development.[182] The Protocol stipulates that JI and emissions trading must be supplemental to domestic action, and therefore must comprise no more than 20% of a Party's target for the first commitment period. Nevertheless, the inclusion of these mechanisms has proved controversial. Many NGOs fear the mechanisms may be exploited, and undermine the objectives of the UNFCCC and the Protocol.

Particularly contentious is the role of 'carbon sinks' within the CDM. As sinks such as forests absorb CO_2 from the atmosphere, articles 3 and 12 of the Kyoto Protocol allow countries to enhance or create a sink in a developing country as a means of meeting their emission reduction requirements. This means that, for example, a rainforest could be sold for its sink capacity to a developed country in exchange for cash.[183] The theory is that the polluter can emit CO_2 equal to the amount of CO_2 the sink can absorb, so that the emission has no impact on the atmosphere. Countries are already considering options in forest management, including reforestation, agro forestry and urban forestry as a means to store carbon rather than reducing their emissions at source. However, there are not only considerable uncertainties associated with sinks - including their capacity to remove CO_2 – but sinks also have the potential to become CO_2 sources. Including the use of sinks within the CDM also creates the danger that indigenous forests will be deforested and replaced by fast growing plantations with a greater capacity to absorb CO_2.[184] Consequently, it seems wise to delay decisions on the use of sinks until further research has been undertaken.

Adaptation funding

In 2001 rich countries spent $70-80 billion on energy subsidies, including subsidies for fossil fuels. Yet they pledged just $0.4 billion a year by 2005 to assist developing countries adapt to climate change.[185] Funding for adaptation measures such as DMP has traditionally been a low priority in overseas aid. The Kyoto Protocol established a climate change adaptation fund, with $500m of new funds a year pledged from the industrialised world, yet this will need to be increased and mobilising more resources generally will require creativity and innovation. There is scope for NGOs to also influence how existing climate change adaptation funds, such as that established within the Kyoto Protocol, are spent.

Opponents of Kyoto

Several arguments have been raised against the Kyoto Protocol. Its primary opponent is the USA. President Bush made the following statement on 13th March 2001: "…I oppose the Kyoto Protocol because it exempts 80 per cent of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the US economy".[186] It is important to realise, however, that the Protocol is a global agreement and therefore does not, in fact, exempt major parts of the world. The 186 Parties to the Convention (which included the US) agreed to its principle of 'common but differentiated responsibilities' for industrialised and developing countries, with the former taking the lead as they have greater wealth and greater emissions.[187] Developing countries that have subsequently signed or ratified the Kyoto Protocol have a general commitment to adopt policies that will mitigate climate change, and to report on their actions. As Grubb states, '…there is a clear understanding that, as industrialised countries start to move their economies onto a less carbon intensive path, the developing countries will follow'.[188]

It has also been argued that the emissions of developing countries will shortly surpass those of industrialised ones, and therefore the notion of 'common but differentiated responsibilities' is unfair. However, industrialised countries produce around two thirds of the world's CO_2 emissions while accounting for less than a quarter of the world's population, and it is predicted that their emissions will continue to be far higher than developing countries' beyond 2020.[189]

A further argument used by opponents of the Kyoto Protocol is that the long–term cost of reducing greenhouse gas emissions as per the requirements of the UNFCCC is very high, and industrialised nations would make a better investment by securing economic growth in developing countries. However, Sir John Houghton refutes this argument: 'Studies show that the necessary action to achieve carbon dioxide emissions (as required by the FCCC), if carefully planned and phased, is likely to cost less than 1% of the Global World Product,

much less than the likely cost of damage and adaptation would be if there was no action at all'.[190]

The Kyoto Protocol will enter into force and become legally binding when it has been ratified by a minimum of 55 countries, including countries that represent 55% of industrialised nations' 1990 CO_2 emissions. At the time of writing, 34 countries have ratified the Protocol, most of which are developing countries. (For up-to-date information on which countries have ratified, see website www.panda.org/climate). Industrialised nations, in signing the treaty, have indicated their intent to ratify it although most are preferring to wait until the details of the Protocol's mechanisms have been concluded before they do so.

To conclude, climate change mitigation processes are underway and NGOs have a part to play in urging their governments to ratify the Protocol as soon as possible and make a more realistic attempt to mitigate climate change through even greater emissions cuts. Reducing greenhouse gases, however, is not just a governmental responsibility. Individuals must also address their own consumption patterns and ensure that the choices they make are environmentally sustainable. Again, NGOs can assist with this by educating their supporters about the effects of climate change and how their choice of lifestyle affects the poor.

Climate change adaptation

'Climate change adaptation is a necessary strategy at all scales to complement climate change mitigation efforts'.[191]

In view of the IPCC's predictions that climate change will increasingly wreak havoc on the developing world, there is an urgent need for the most vulnerable countries to take immediate adaptive measures. Until recently discussions around adaptation have been limited, as the climate change agenda has been driven by environmental groups whose primary objectives have been to reduce greenhouse gas emissions in order to protect the environment. However, as developing countries continue to suffer the effects of global warming in the form of storms, floods and droughts, climate change is being increasingly viewed as a humanitarian concern as well as an environmental one, and the need for adaptation is now a priority. As the British Red Cross states, 'While fighting (climate change), the world has no choice but to also find ways of living with it'.[192]

It is sometimes argued that prioritising adaptation to future climatic disasters is less critical than dealing with current crises facing developing countries (such as HIV/AIDS). However, Helmer observes the following: 'The speed and impact of disasters will increase. I do not think that we can say that it will be business as usual. If we do we will not be able to cope'.[193] In order to 'cope' with the effects of climate change in the future, adaptation must begin today.

Disaster Mitigation and Preparedness

Disaster mitigation and preparedness (DMP) is a vital component of adaptation to climate change. Major hurricanes and floods attract instant media interest and rapid humanitarian response, but it is not enough to support immediate crises through relief activities without enabling communities to prepare for and mitigate the effects of future disasters. When community and national level DMP is undertaken in developing countries, it reduces the negative impacts of extreme weather events. For example, cyclone shelters in the Bay of Bengal have proved effective in saving lives in the event of major cyclones (such as that of 1991). Also, drought in Africa in the 1960s, 70s and 80s resulted in widespread starvation and loss of life but in the 1990s a similar disaster was avoided as a result of the establishment of more effective early warning and response systems.

A large range of preparedness and mitigation measures are possible, many of them relatively cheap and simple to implement. They are also cost-effective: the World Bank has calculated that economic losses worldwide from climate related disasters could be reduced by 280 billion US dollars by investing just a seventh of that sum in disaster preparedness.[194]

Local level/community flood preparedness and mitigation includes:

- Ensuring that buildings are storm/flood proof
- Constructing, or turning an existing building into, an emergency shelter
- Establishing evacuation routes
- Protecting water supplies
- Preparing emergency supplies of food
- First aid training
- Reforestation

Local level/community drought preparedness and mitigation includes:

- Enhancing agricultural production
- Establishing community grain banks
- Food preservation
- Improved water resource and watershed management
- Deep wells
- Drought-resistant crops
- Adapting planting schedules
- Soil preservation

National level DMP for floods and droughts includes:

- Conducting regional vulnerability assessments
- Establishing early warning systems

- Providing communities with 'safe' land for building, i.e. away from flood-prone areas
- Strengthening infrastructure (such as roads and bridges)
- Large-scale reforestation
- Protecting watersheds
- Good urban planning

It is important that both national and local level DMP is undertaken in a vulnerable region. As most lives are saved during the first 48 hours of a disaster, and national or international emergency relief aid often does not arrive until 72 hours after the disaster has occurred, communities need to be equipped and taught how to help and save themselves and their livelihoods. While national early warning systems, for example, are a very necessary DMP measure, if communities do not know how to respond to these warnings, lives will still be lost.

NGOs can play a vital role in both raising governmental awareness of the need to engage in DMP, and working alongside local and central government to implement community-based disaster preparedness and mitigation planning.

Influencing National Policy

As global warming will increasingly affect the poor over the next century, the implications of climate change for sustainable development *must* influence national policy. Decision makers and politicians should be aware of their country's level of vulnerability and adaptability to climate change, and subsequently implement sustainable development initiatives that *maximise the benefits* of climate change while *minimising its risks.*[195] There are several national policies and strategies that should take climate change into account:

Poverty Reduction Strategy Papers

In 1999 the World Bank/IMF required countries seeking debt relief under the HIPC Initiative to produce a Poverty Reduction Strategy Paper (PRSP), detailing how they would use debt relief money to reduce national poverty. Each country now has to research the causes of poverty and draw up a plan to tackle the problems identified, which must be backed by all partners (donor countries and agencies). PRSPs are very important; not only do the World Bank and the IMF plan to extend the PRSP approach from the 40 HIPCS to all countries receiving assistance from the International Development Association (20-30 additional countries), but PRSPs are also likely to become the framework into which other donors will direct their funds.

PRSPs offer good opportunities for input from civil society. If a PRSP process is underway, those seeking to advance DMP could draw their government's attention to the country's vulnerability to climate change and disasters and ensure that this is adequately accounted for and addressed within the PRSP. Some Tearfund partners have observed that their country's draft (or 'interim') PRSP lacks sufficient attention to long-term climate and environmental issues and has little or no focus on disaster preparedness and mitigation, and they have raised this concern with their government. Where a PRSP has already been agreed, NGOs have a role to play in pushing for its implementation and monitoring.

It is worth noting that countries may have a strategy for tackling poverty but called by a different name, such as Bolivia's 'National Dialogue'. Other strategy-making processes exist in addition to PRSPs, such as the National Strategy for Sustainable Development (NSSD) which every country should have in place by 2005. Discussion is currently underway over the need to bring all these strategies together, or at least ensure that they do not conflict with each other.

Sectoral Planning

Climate change and disaster preparedness and mitigation need to be fully integrated into other appropriate national sectoral and cross-sectoral policies and strategies. These include land and water management, agriculture, rural development, health and education. For example, an already water-scarce country anticipating a decline in rainfall as a result of global warming must take this into account in its water resource management strategy (this may involve developing new water sources and infrastructure to mitigate the impacts of drought) and its agricultural policies (which must seek to increase food security).

NGOs may need to engage in advocacy at the national level to ensure their government implements environmental and developmental policies that take account of climate change. Climate change increases the already present need for national policies to address the country's sustainable development requirements. For example, the IPCC observes that systems most vulnerable to global warming are likely to be '…unmanaged water systems and systems that are currently stressed or poorly and unsustainably managed due to policies that discourage efficient water use and protection of water quality…'.[196] The threat of decreased rainfall, therefore, renders the need for improving such poorly managed water systems within a particular region even more crucial.

It is important to remember that climate-related disasters are expected to increase not only as a result of global warming but also as a result of human-induced environmental destruction. Indeed, with reference to Latin America the IPCC asserts that the impact of climate change on the region must be considered alongside the impact of unsustainable land-management practices and increasing population, and states, 'In most cases, it is impossible to separate the effects of these impacts, and land-use impacts and population growth are expected to result in more severe changes than are changes in climate'.[197] The IPCC observes, for example, that even if climate change brought wetter conditions to Latin

America, human activity could '…escalate the desertification process'.[198] Therefore, national policies must take account of climate change as well as address other practices that destroy the environment such as illegal logging and unsustainable agriculture.

Disaster Management Strategies

Some Tearfund partners have observed a lack of attention to disaster mitigation and preparedness in their countries' disaster management strategies. Through discussions with these partners it is apparent that some national governments focus on relief and reconstruction while ignoring the need for pre-disaster planning (with much of this reconstruction failing to take into account the risk of future disasters). It has also been observed that where governments *do* recognise the need for disaster preparedness, they have tended to focus on the development of large-scale technology such as national early warning systems while ignoring the need to teach local communities how to prepare for and respond to disasters. There is scope, therefore, to influence national government disaster management planning to ensure that sufficient attention is place on pre-disaster planning – including at community level.

The World Summit on Sustainable Development

The World Summit on Sustainable Development (WSSD) will be held in Johannesburg in August 2002. The WSSD is a follow up to the 1992 Rio Earth Summit, and is the biggest poverty summit for a decade. Agenda 21 (a global action plan to achieve sustainable development) was agreed at the Earth Summit. Following a review of global progress in implementing Agenda 21, the WSSD aims to set new priorities for the 21st century and establish how these priorities will be achieved. Unlike the Earth Summit, the focus this time is on poverty and linking the environment to social and economic development. It is agreed that The Millennium Development Goals[199] should form the basis of the implementation plan the Summit aims to deliver.

It is hoped that the Summit will reinvigorate the spirit of Rio and move the world into a deeper level of sustainable development. Agreements made in Johannesburg must be followed up, and both Northern and Southern governments should be held accountable for any failure to act on them. NGOs can play a role in this through following the progress made by their governments in pursuing the implementation document forthcoming from the WSSD and assisting or challenging implementation, or lack of it, where necessary.

Issues high on the agenda of the WSSD, and that are particularly relevant to the issues outlined in this paper, are water and sanitation, energy, climate change adaptation, and food security. There is a significant amount of attention paid to climate change adaptation within the WSSD draft Plan of Implementation,[200] including a focus on the need to assist developing counties prepare for and mitigate disasters at community and national level.

NGOs should learn exactly what agreement was made at the WSSD in the area of climate change mitigation so that, working with their governments, they can maximise its potential.

To summarise this section on influencing national policy, 'The message…is clear: future risks can be reduced if climate change is incorporated into all current planning'.[201]

Conclusion

The fact that climate change has serious consequences for development is revealed through the growing numbers of humanitarian catastrophes, the imminent disappearance of coastal zones and even small island states, and the steadily growing numbers of 'environmental refugees' that the world is experiencing as a result of higher temperatures and rising sea levels. The Centre for Advanced Studies in Bangladesh has calculated that 'every dollar invested in the country is absorbed by the cost of dealing with predictable disasters'.[202] Unless the development community recognises that climate change is already happening and takes the predictions of the IPCC seriously, development efforts will be made in vain and the poor will become poorer.

Response to the issue of climate change must take the following forms:

- Global climate change mitigation processes are underway but these are insufficient to address the problem. Northern governments must be urged to commit to deeper cuts in greenhouse gases in the near future.

- Climate change mitigation is not just the responsibility of governments. Business and industry must begin the transition to 'clean' technology and individuals must assess their own lifestyles and ensure that they are doing all they can to minimise their own contribution to global warming.

- Adaptation to climate change – such as disaster preparedness and mitigation - is essential to safeguarding progress made in development. It also proves cost effective; as the NGO Christian Aid observes, "A number of attempts have been made in recent times to estimate the cost of anthropogenic climate change worldwide. The results of these analyses are unmistakeable: in the long term the cost of preventive strategies is much lower than the losses to be expected as a result of climate change".[203]

- Climate change must be accounted for in all local and national development planning. As the IFRC states, '…future development decisions must be viewed through the lens of risk reduction'.[204] Climate change intensifies the need for governments to have national policies in place that address their country's sustainable development needs.

The issue of climate change must be addressed as a matter of urgency. If it is not, as a recent headline in The Guardian declared, 'The social and economic costs of global warming will block all progress in the developing world'.[205]

Questions for discussion

1/ How should the climate change impacts that have been predicted for Latin America, southern Africa and Asia influence the formation of national and local policy in these regions?

2/ What are the implications of climate change for trade, both in developed and in developing countries? (On average, 1 tonne of carbon is produced for every $3,000 of World GDP)

3/ How can climate change be incorporated into Tearfund's strategy for disaster management?

4/ How should the implications of climate change as outlined in this report influence relief and development project appraisal? (For example, how should Tearfund respond to community development that fails to integrate risk reduction?)

5/ How should climate change influence Tearfund's allocation of resources?

6/ How can we ensure that project proposal, implementation and appraisal are 'viewed through a lens of risk reduction'?

7/ What messages should Tearfund and other NGOs be conveying to supporters?

8/ How can NGOs raise public and government awareness of the issues raised in this paper?

9/ How can NGOs be encouraged to undertake advocacy around some of the issues raised in this paper?

10/ What messages around climate change should we be conveying to the media?

References and Useful Resources

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Useful resources

Key resources already referenced in the bibliography are as follows:

World Disasters Reports 1999, 2000, 2001 and 2002
(provide disaster data and in-depth analysis of disaster impacts and mitigation).
Website: www.ifrc.org has more information. To order the books telephone: (44) (20) 7240 0856

IPCC Special Report The Regional Impacts of Climate Change: An Assessment of Vulnerability – Summary for Policymakers
(Contains detailed information on the regional impacts of climate change).
Available online at www.ipcc.ch

Summary for Policymakers (A Report of Working Group 1 of the Intergovernmental Panel on Climate Change)
(Contains global climate change data and predictions)
Summary for Policymakers Climate Change 2001: Impacts, Adaptation, and Vulnerability
(Contains assessment of climate change impacts and global/regional vulnerability
Both summaries available online at www.ipcc.ch

Global Environmental Outlook 2000 (2002 edition out now)
(Contains detailed global and regional environmental analysis and policy responses)
For these and other relevant resources contact:
United Nations Environment Programme
PO Box 30552, Nairobi, Kenya
Tel: +254 2 621234
E-mail: geo@unep.org
http://www.unep.org

United Nations Framework Convention on Climate Change (UNFCCC) Climate Change Information Kit
(Contains highly accessible summaries of climate change impacts)
Available online at www.unfccc.int

Useful websites:

The World Wide Fund for Nature (for analysis of climate change, the UNFCCC and the Kyoto Protocol): www.panda.org/climate

Tearfund: www.tearfund.org and www.tilz.info (international website)

The Tyndall Centre for Climate Change Research: www.tyndall.ac.uk

The Hadley Centre for Climate Prediction and Research: www.metoffice.com

United Nations Environment Programme: www.unep.org

United Nations Development Programme: www.undp.org

World Bank: www.worldbank.org
Inter-American Development Bank: www.iadb.org
(includes information on sustainable development, climate change and DMP)

World Health Organisation: www.who.int
Pan American Health Organisation: www.paho.org
(includes information on the effect of climate change and disasters on health)

World Summit on Sustainable Development website: www.un.org/rio+10
(information about the Summit process including the draft Plan of Implementation)

***International Federation of Red Cross and Red Crescent Societies*:** www.ifrc.org
(includes information on DMP and DMP case studies)

Relevant Tearfund resources:

- ***Poverty and the Environment –*** an information briefing
- ***Thirsty World –*** an information and discussion paper on water
- ***When Disaster Strikes*** - Tearfund media report on disasters
- Tearfund media reports on water and sanitation
- Discussion paper on sustainable consumption (forthcoming)
- Advocacy Toolkit ***Understanding Advocacy***
- PILLARS Guide ***Preparing for Disaster*** (Information for community groups to use and discuss)

All of these resources are available on Tearfund's international website.

Christian Perspectives on Disaster Management Training Manual (and Trainer's Guide), Interchurch Relief and Development Alliance
(Contains guidance on how to lead disaster management workshops)

Further information on Tearfund resources is available from:
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E-mail: international@arocha.org

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Harrogate, N. Yorkshire. HG2 8DD, UK
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E-mail: cel2000@Christian-ecology.org.uk

The World Council of Churches (provides an in-depth analysis of climate change)
PO Box 2100,
1211 Geneva 2, Switzerland
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