

Climate Change in South Asia

Emerging Challenges & Responses



South Asian Network for Social & Agricultural Development

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Foreword

This paper is a preliminary report based on secondary sources and published articles by organisations such as the United Nations Intergovernmental Panel for Climate Change (IPCC) and others. This brief paper will be subjected to further revision based on discussions at different levels and feedback that we receive from partners and associates in South Asia. We are expecting to receive critical feedback and inputs to further improve this manuscript in order that it becomes an educational and interesting source of information for the reader.

Climate change as an issue has been there since last 50 years but this issue gained momentum and came to the forefront in last five years or so once the European Countries and the United States of America (the developed world) started to feel the heat of the climatic change in the form of large scale floods in the United States, the wholesale destruction of New Orleans by hurricane Katrina, the heat waves over Europe among other such uncharacteristic climatic behaviours.

It's been estimated that if we take the EU, USA and Canada together which forms a major portion of the developed countries they account for only 14 per cent of the world's population but is responsible for 61 per cent of CO₂ emission where as a major portion of the developing countries i.e. India and China comprising 37.1 per cent of the global population are responsible for 22 per cent of carbon emission. More over underprivileged masses of the developing countries have been suffering a lot due to climatic change. Thus we put forth the argument that the developed countries should take the lead in this campaign as they have the financial capacity, the technological know how and also are mainly responsible for climatic problems. Along with this the developed countries should also come forward and provide help to the poor and developing countries that have been facing the wrath of climatic change and global warming in the form of floods and droughts, something that the developed countries have still not done whole heartedly.

Some unreparable damages have taken place such as fast melting of Himalayan glacier which will cause drying of rivers such as Ganga, gap in the ozone layer etc. This report raises the question as to who will take the responsibility and pay for these damages.

SANSAD is thankful to Narender Kumar, Director of Indraprastha Public Affairs Centre (IPAC) for helping to collate information used in this article. SANSAD is also thankful to Sanjay Vashist, Coordinator, CAN South Asia for giving his valuable inputs and helping at every step in finalizing the report.

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Sincerely,



Anil K Singh
Secretary-General

Introduction



Global warming as a result of climate change has raised the awareness and environmental consciousness of the global community. Whilst the effects of greenhouse gases and its effect on the environment may grace our news screen for a brief time, these issues, although important, have been overshadowed by more pressing concerns such as the global war on terror and the recent economic depression. Even though the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) has constantly reminded us of the dangers that climate change can impose on society, a sense of urgency in combating global warming has only recently taken hold amongst the global community.

Whilst developing countries have for some time, been facing the forces of nature of ever increasing severity, it was not until developed nations also began to come under such onslaught that the global community even acknowledged and responded to this challenge. Large scale floods in the United States, the wholesale destruction of New Orleans by hurricane Katrina and the uncharacteristic heat wave that hit Europe finally stirred into action those decision makers and influential thinkers of the West. Amongst those leading the charge is the former US vice-president Al Gore whose documentary film entitled “An Inconvenient Truth” managed to reach out to those still largely ignorant of the looming crisis. The 2007

UN conference on climate change which took place in Bali, Indonesia, eventually set the stage for collective action by the international community to address the issue of climate change in an appropriate manner and timely fashion.

Finding lasting solutions to poverty, environmental regeneration and sustainable development is now being viewed as central to any collective endeavour for tackling climate change. To this end, civil societies across the globe have lent their incredible resources to streamline and accelerate this process. The South Asian Network for Social and Agricultural Development (SANSAD), which is a regional network of civil society organisations in South Asia, together with Indraprastha Public Affairs Centre (IPAC) and other independent organisations, carried out a brief analysis of the potential impacts that climate change may have on South Asia. This paper collates information from a variety of sources and aims to provide a framework for collective action and heightened coordination between civil societies as well as provide a reference for policy makers at the South Asian level.

As have been mentioned, this paper is a brief assessment, and after having feedback from the public and experts of the subject, we would be happy to revise and update this paper.

GLOBAL WARMING

The planet’s environment is constantly

changing and experiences periods of cold and warmth. When global temperatures occurred at an unprecedented rate, the scientific community began to debate and wonder about the cause for this phenomena. The question that came up time and again is whether the change was a result of natural causes or perhaps a consequence of the actions of man. Countless discussions ended with a consensus that the planet warmed as a result human activity.

Pre-industrial levels of carbon dioxide (CO₂) prior to the start of the industrial revolution were about 280 parts per million (ppm) by volume and current levels are greater than 380 ppm. The global concentration of CO₂ in our atmosphere today far exceeds the natural range. Owing to excessive CO₂ emission and the release of other greenhouse gases such as methane (CH₄) and nitrous oxide (N₂O) as a result of increased human activities, these gases are now accumulating in the atmosphere which causes the retention of sunlight in the atmosphere above normal levels making the earth much warmer than it actually is. Under normal conditions, when light from the sun reaches earth, approximately 30% of the rays are reflected back into space by clouds, atmospheric particles, reflective ground surfaces, and the ocean surface. The remaining 70% of the sunlight is absorbed by the land, air and ocean, heating our planet's surface and atmosphere and making life on earth possible. However, certain gases in the atmosphere absorb this heat (sunlight) and reflect them back towards earth's surface thereby warming the planet. These gases are known as greenhouse gases because they effectively 'trap' heat in the

lower atmosphere of the planet. Water vapour is the most abundant greenhouse gas, followed by CO₂ and other trace gases. Without the natural greenhouse effect, earth's temperature would fall below zero. Solar energy does not stay bound in the earth's environment forever. Instead, as the rocks, air, and the sea warm, they emit thermal radiation or infrared heat. Much of this thermal radiation travels directly out to space, allowing the Earth to cool.

Thus, the greenhouse effect helps regulate the temperature of our planet. However, it was observed that there has been a substantial increase in the concentration of greenhouse gases in the atmosphere. The concentration of CO₂ has increased by 36%, CH₄ by 17%, and N₂O by 151% leading to an overall increase in concentration of greenhouse gases in the atmosphere (mostly CO₂ from combustion of coal, oil, and gas). Because of this, an increasing amount of heat from the sun becomes trapped within earth's atmosphere. As more heat is being stored in the planet than is released back into space, the planet warms up artificially – global warming has occurred.

The UN Development Programme (UNDP) sets the threshold for "dangerous" global warming at an increase of about 2°C above present levels. Should world temperatures increase above this threshold, irreversible ecological damage with untold impacts on human development will occur. Temperatures have already increased by 0.8°C over the past hundred years (since 1880) and it is projected that a continuation of the current trend of greenhouse gas emissions will inevitably lead to temperature rising by more than 5°C by the end of the 21st century.

CAUSES OF CLIMATE CHANGE

Global warming leading to climate change is a result of human or anthropogenic (man-made) activities as well as the result of natural processes. Natural processes are naturally occurring events such as the release of CH_4 gas from the arctic tundra and wetlands. The earth also goes through a natural cycle of climate change every 40,000 years. Human activities are the most significant contributor of global warming due to the irreversible damage that it causes (Figure 1). Pollution is one of the biggest man-made problems. Burning of fossil fuels such as coal and oil is a major cause of pollution. When fossil fuels are burned, they release CO_2 . Mining coal and drilling for oil also enables CH_4 trapped below ground to escape to the surface thereby increasing the amount of greenhouse gases in the environment.

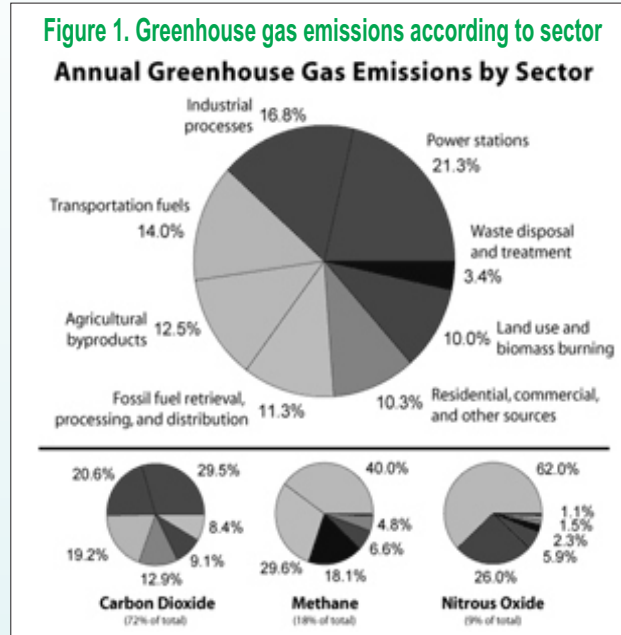
Another major man-made cause of global warming is the exponential rise in the global population. Since CO_2 contributes to global warming, the increase in population makes the problem worse because we breathe out CO_2 . The increase in the number of oil/gas-consuming vehicles on the road also contributes to an increase overall CO_2 emission. About 20% of CO_2 released to the atmosphere comes from burning of gasoline/oil in the engines of automobiles. However, the primary source of CO_2 emission is the burning of fossil fuel in power plants for electricity generation.

Additionally, a growing population also requires an increasing amount of food to sustain itself which then creates the need for more intensive agriculture to meet food supply and demand. Rice is a staple food for

people in many parts of Asia. When rice fields are flooded, an anaerobic (lack of oxygen) environment is created which causes organic matter in the soil to decay and release CH_4 to the atmosphere. It has been reported that CH_4 is twenty times more efficient than CO_2 at trapping heat in the atmosphere. Other avenues for releasing CH_4 include bovine flatulence, bacteria in bogs and as mentioned before, the mining for fossil fuel. The main sources of N_2O emission comes from the production of nylon and nitric acid, cars with catalytic converters, the use of fertilisers in agriculture and the burning of organic matter. Another cause of global warming is deforestation that is caused by cutting and burning of forests for urban expansion and industrialisation. As trees naturally convert CO_2 to oxygen, its removal would mean a continual build up of the concentration of CO_2 in the atmosphere.

Its been estimated that if we take the EU, USA and Canada together which forms a major portion of the developed countries they account for only 14 percent of the world's population but is responsible for 61 percent CO_2 emission where as a major portion of the developed countries i.e. China and India comprising 37.1 percent of the global population and responsible for 22 percent of carbon emission.



Figure 1. Greenhouse gas emissions according to sector**Table 1: Global population compared to CO₂ emission as a percentage**

Country	% of world population (2004)	% of world CO ₂ emissions (2004)
EU	7.2	20.0
USA	4.5	20.9
Canada	2.2	20.0
China	20.0	17.3
India	17.1	4.6

Table 2. CO₂ emissions per capita

Country	ton/year CO ₂ emitted per capita (2004)
EU	8 – 10
USA	20.6
Canada	20.0
China	3.8
India	1.2

Based on Table 1 and 2, it is clear that industrialised countries are primarily responsible for global warming. Although

rapidly developing nations such as China and India amongst others, are contributing to increased carbon emissions, their per capita emissions remain far below those of developed countries.

Despite this, those who have largely contributed to the problem – the rich countries and the wealthy amongst the citizens of developing countries – are not going to be the ones who will suffer the effects of climate change the most. Rather, it will be the poorest community, which consequently would not have contributed significantly to greenhouse gas emissions that will be most vulnerable to the impacts of global warming. In fact, climate change has already started to affect some of the poorest and most vulnerable groups around the world. Millions of the world's poorest people already have to cope with the effects of climate change. For example, farmers in drought-affected areas have switched to crops that are relatively drought-tolerant but have lower yields in return and this has affected their earnings. Between 2000 and 2004, an average of 262 million people a year was affected by climate-related disasters - 98 % of them were living in the developing world.

THE IMPACTS OF GLOBAL WARMING

Global warming will lead to extreme climatic changes and weather patterns which may include less predictable rainfall and intensity, an increase frequency and magnitude of tropical cyclones as well as monsoon that will become more temperamental in their strength and time of onset. The impacts of climate change will vary from one region to another but the Asia-Pacific region is likely to

experience significant adverse consequences due to its location.

Because the Asian region spans polar, temperate, and tropical climates and is home to over 3 billion people, once the climate warms, many mountain glaciers may disappear, permafrost will thaw and the northern forests are likely to shift further north, arid and semi arid regions will suffer further shortage of water while tropical, temperate and boreal region will experience increase in flooding. Rapid population growth and development in countries like China and India will put additional pressure on natural ecosystems and will lead to a rapid increase in the release of greenhouse gases into the atmosphere unless steps are taken to curtail emissions.

One should not forget that Asia is also home to the world's largest and most populous continent. It covers 8.6% of the earth's total surface area (or 29.4% of its land area) and with over 4 billion people, Asia accounts for more than 60% of the world's population. Some of the devastating effects of climatic change that Asian countries are likely to face include:

Coastal communities: All of the studies, whether conducted at a regional or national level, indicated that the region's coasts would experience climate damages in the decades



ahead. Sea levels will rise by at least 0.4 m by 2100 and submerging vast areas on the coastline, including some of the most densely populated cities. In the provisional 16 February 2007 IPCC report on Asia, it is projected that those living in coastal areas will be forced to migrate inland or build dykes – both requiring a financial and logistical challenge that will be unprecedented. In the South Asian region as a whole, millions of people will find their lands and homes inundated. Small island states would be swallowed by the sea. Most at risk are the low-lying river deltas of Bangladesh, India, Vietnam, and China as well as the small island states.

1. **Ecosystems and biodiversity:** The natural ecosystems of the Asia-Pacific region will face increasing pressure from human activities. These factors will reduce the resilience of the present ecosystems to the effects of climate change. Coral reefs termed the “rainforests of the ocean” because of the critical habitat they provide to sea creatures, are likely to be damaged from increases in the frequency of bleaching events, whilst the region is likely to lose 1-13% of its mangrove wetlands – with larger proportional losses for some individual nations. Changes in the high altitude biomes of the Tibetan Plateau may see desert and steppe systems give way to forests and grasslands. Furthermore, existing grasslands of the arid regions in central Asia and the boreal forests of China are projected to decline.
2. **Water resources:** Managing water resources to ensure a secure supply to

growing populations is already a major challenge facing many areas of the Asia-Pacific region. Climate change is likely to reduce availability of water resources due to seasonal reductions in rainfall and runoff in South and Southeast Asia as well as an increase in runoff in other areas, particularly the Pacific Islands. On a regional scale, water scarcity is likely to affect millions of people throughout the region, and the costs for managing water resources will rise. By contrast, unprecedented rise in rainfall may increase the likelihood of floods occurring.

3. **Glacial melt:** Melting of glacier in the initial few years (it is projected that global temperatures will increase by 1.2°C by 2040 and the Himalaya glacier will vanish entirely by 2035). This will increase heavy volume of water in rivers resulting in floods in different parts of the country. Due to floods, there will be erosion of top fertile soil and siltation in ocean beds and increased volume of water in the ocean. Consequently, the Ganga, Brahmaputra, and Indus will become seasonal rivers, dry between monsoon rains as Himalayan glaciers will continue their retreat, vanishing entirely by 2035, if not sooner. Water tables will continue to fall and the gross per capita water availability in India will decline by over one-third by 2050 as rivers dry up, water tables fall or grow more saline.
4. **The southern Asian monsoon:** The southern Asian monsoon is one of the most important and influential phenomena of earth's climate system.

Most of the population of Southeast Asia is entirely dependent on variability in the onset and duration of the monsoon which has profound impacts on water resource, human life, agriculture, economics and ecosystems. These monsoons are expected to become more temperamental in their strength and time of onset. Researchers have also identified a tendency towards fewer and more extreme downpours which can lead to floods and can cause substantial damage to infrastructure, property, animal and people.

5. **Agriculture and forestry:** Studies indicate a high degree of spatial variability in the vulnerability of Asia-Pacific agriculture to climate change. Crop productivity will fall, especially in non-irrigated land, as temperatures rise in all of South Asia by as much as 1.2°C on average by 2040, and even greater crop loss — of over 25% — as temperatures rise to up to 5.4°C by the end of the century. This means an even lower caloric intake for India's vast rural population, already pushed to the limit, with the possibility of starvation in many rural areas dependent on rainfall for their crops. Furthermore, areas currently in water crisis, such as northeast China and flood-prone river deltas of Bangladesh and Vietnam, are likely to experience significant land degradation and loss in a changing climate. For the least developed nations, such agriculture impacts may threaten not only food security, but also national economic productivity.
6. **Disease and heat-related mortality:** Changing patterns of temperature and

rainfall will likely cause shifts in the distribution of dengue and malaria-carrying mosquitoes. On a local scale, disease risk will increase for some and decrease for others, but on a regional scale, the net effect is projected to expose millions of additional individuals to such infectious diseases by the end of the century. Higher temperatures may reduce the risk of cold-weather mortality, but increase heat-related mortality, with the poor, the elderly and daily wage earners and agricultural workers suffering a rise in heat-related deaths, whilst increased flooding and intensification of tropical cyclones would increase climate-related injuries and deaths.

7. **Regional economies:** The net effect of climate change on regional and national economies is projected to be largely negative. Loss of agricultural revenue and additional costs for managing water resources, coastlines, and disease and other health risks will be a drag on economic activity. Given long-term, sustainable economic development and growth in per capita wealth, such economic impacts may comprise a declining portion of total economic welfare, and regional capacity to effectively manage climate risk is likely to rise. However, a number of Asia-Pacific nations currently have sluggish or stagnant economic growth that, in some instances, is projected to persist for the foreseeable future. Furthermore, even with growing regional prosperity, localised climate impacts, such as the collapse of a fishery or the inundation of

core cropping land, could devastate local economies.

8. **Threat to world peace:** Another important effect of climatic changes could be the mounting tension between wealthier and the less fortunate nations. The wealthier nations will seek to preserve their resources whilst lesser nations, especially those with ancient enmities with their neighbours, may initiate struggles for access to food, clean water, or energy.

GLOBAL CONCERN ON CLIMATE CHANGE

Consensus is emerging that the average world temperatures should not be allowed to increase further. Efforts are being made by various nations to cut down the rate of global warming. One such effort is the Kyoto agreement that has been made between various nations to reduce the emissions of various greenhouse gases. The concentration of greenhouse gases in the atmosphere should be stabilised. In order not to exceed this concentration, CO₂ emissions in the 21st century should be limited. This is what is referred to as our “21st century global carbon budget”. Staying within the limits of our 21st century carbon budget will require us to make a 50% reduction in greenhouse gas emissions by 2050. This 50% reduction target is definitely achievable, with sufficient political will. Between now and 2030, the average annual cost would amount to 1.6% of the world’s gross domestic product (GDP). The costs of inaction would be much higher: they could reach 5–20% of world GDP.

This global target must be translated into national targets. When doing so, the principle

of “common but differentiated responsibility” should be applied:

- Developed countries should take the lead. They carry the burden of historical responsibility for the climate change problem (they have a huge historical ‘carbon debt’ to pay) and they have the financial capacity and technological know-how to make deep and fast emission cuts.
- Developing countries should be allowed to make the transition to a low-emission growth path at their own pace, taking into consideration their need for sustained economic growth and poverty reduction. Consequently, rich countries will have to transfer the finances and technologies to help developing countries make that transition not in the form of loans, but in the form of non-repayable grants.

The UNDP (2007) proposed that:

- Developed countries should cut their greenhouse gas emissions by at least 80% by 2050 (compared to 1990 emission levels), with 20 – 30% cuts by 2020.
- Major emitters amongst the developing countries (China, India) should let their greenhouse gas emissions reach their peak by 2020 and make 20% emission cuts by 2050 (again compared to 1990 emission levels).

Intervention is going to be essential in bringing about the necessary cuts in greenhouse gas emissions. The following policy instruments and mechanisms have been proposed:

- The cornerstone of any mitigation program will have to place a price on greenhouse gas emissions. People intending to emit CO₂ in the air (through use of vehicles for transportation etc.) should be heavily taxed to discourage such practices. This price should be high enough to reflect the social cost of greenhouse gas emissions and to provide enterprises and consumers with an ‘incentive’ to reduce their emissions.
- Elimination of subsidies for fossil fuels.
- Setting regulatory standards, e.g. energy efficiency standards.
- Supporting (i.e. financing, providing incentives for, providing regulatory support) the development and use of low-carbon technologies, e.g. renewable energy sources, carbon capture and storage technology amongst others. Financing, providing research assistance and transferring of such technology to developing countries.
- Cooperation to support forest conservation and water conservation.

ADAPTATION

Adaptation means enabling people to manage climate-related risks (floods, drought, storms etc.) without suffering backward progression in human development. It involves rapid sustainable and equitable development that will increase income levels, education and technical skill, improve public food distribution, disaster preparedness and management and health care systems and reduce vulnerability. This means developing

new institutions or modifying existing ones to promote adaptation to climate change. It would also involve modifying climate-sensitive infrastructures already planned or implemented or other long-term decisions that are sensitive to climate.

Ultimately, adaptation is nothing but an exercise in damage limitation. It deals with the symptoms of a problem that can only be overcome through mitigation. Yet, adaptation has become a necessity. Even the most stringent mitigation program will fail to avoid temperature increases (and therefore, climate-related disasters) that have become inevitable because of those greenhouse gases already accumulating in the atmosphere and because of the time lag between mitigation efforts and their result.

Adaptation should involve:

- Providing information on climate risks. Through, e.g. the establishment of meteorological stations.
- Developing institutions for risk management, e.g. early warning and response systems.
- Investing in infrastructure, e.g. flood defence structures, irrigation facilities and wells amongst others.
- Developing social protection programmes aimed at securing people's access to food, income, health care and education.

CHANGES IN SOUTH ASIA

It is now a well known fact that climate change is no longer an issue that may happen in the distant future. It is a reality already taking place around us and ironically the people in South Asian countries, particularly the



poorest people, are most at risk. The impacts of higher temperatures, erratic rainfall, extreme weather patterns and significant rise in sea levels are being felt in South Asia, and unfortunately this will continue to intensify. These changes are having huge impacts on the lives and livelihoods of millions of poor people. The impacts arise not only from gradual changes in temperature and sea level but also, in particular, from increased climate variability and extremes, including more intense floods, droughts, and storms.

Some of the future impacts include:

- Glacier melting in the Himalayas is projected to increase flooding and will affect water resources within the next two to three decades.
- Climate change will compound the pressures on natural resources and the environment due to rapid urbanisation, industrialisation and economic development.
- Crop yields could decrease up to 30% in South Asia by mid-21st century.
- Mortality due to diarrhoea primarily associated with floods and droughts will rise in South Asia.
- Sea-level rise will exacerbate inundation,

storm surge, erosion and other coastal hazards.

The consequences of such environmental changes include:

1. Decreased water availability and water quality in many arid and semi-arid regions

There will be an increased risk of floods and droughts in many regions. Heavier rainfall during the summer monsoon could increase flooding. In August 2007, British aid agencies, including those in the Working Group, asked the United Kingdom public for funds to assist up to 28 million people affected by flooding in South Asia. Most water sources in affected areas of India, Bangladesh and Nepal were said to be contaminated or submerged.

2. Reduction in water regulation in mountain habitats

Glaciers are the freshwater reservoirs at the top of a mountain watershed and act as the source of many rivers that wind their way through thousands of kilometres of grazing, agricultural and forested land, and are used as a source of irrigation, drinking water, energy and industry. Hundreds of millions of people throughout China and the Indian subcontinent – most of whom live far from the Himalayas – rely on water supplied from these glaciers. As rising temperatures in the region melt the glaciers, glacial lakes are rapidly filling with water. Many are now close to bursting – causing glacier lake outburst floods. The IPCC has concluded with high confidence that climate change has caused ‘enlargement and increased numbers of glacial lakes’. Such events have devastating impacts on mountainous ecosystems and infrastructure.

3. Decreases in reliability of hydropower and biomass production

Earlier snow melt and ensuing changes to

water availability could affect hydropower infrastructure and efficiency. For instance, while Nepalese rivers can potentially provide 43,000 MW of electricity, changing rainfall patterns and timing of snow melting could reduce this potential.

4. Increased incidence of water-borne diseases such as malaria, dengue, and cholera

According to the IPCC, daily mortality and morbidity increases during very hot weather in Asia. The elderly and the urban poor are most vulnerable. In May 2002, in the state of Andhra Pradesh temperatures rose to 48.9°C, resulting in the highest one-week death toll on record. Given the IPCC Third Assessment Report projections of surface temperature increase of 1.4 to 5.8°C from 1990 to 2100, it is likely that heat related mortality and morbidity in the region will increase substantially. Adverse health impacts in South Asia region also result from the build-up of high concentrations of air pollutants such as NO₂, ozone, and air-borne particulates in large urban areas. Combined exposures to higher temperatures and air pollutants appear to be critical risk factors for cerebral infarction and cerebral ischemia during the summer months.

5. Increased damages and deaths caused by extreme weather events

In temperate Asia, the IPCC also forecasts that an increase in the frequency or severity of heat waves would cause an increase in (predominantly cardiorespiratory) mortality and illness. Studies of urban populations also indicate that the number of heat-related deaths would increase several-fold in response to modelled climate change scenarios for 2050.

6. Decreased agricultural productivity

Disruption to the region's water cycle caused

by climate change also threatens security and productivity of the food systems upon which they depend. The changes in water security and environmental flows will not only affect health of the people of Asia but also agriculture yields for the domestic and export market. This is an international issue with the UN Food and Agriculture Organisation (FAO) estimating that climate change could cost 65 developing countries about 280 million tons in lost cereal production, equivalent to about 16% of agricultural output. Across the developing world, climate change could potentially reduce the amount of rain-fed land by 11% by 2080. The IPCC has already recorded a temperature increase of 1°C since 1970 in temperate Asia and many other studies indicate reductions in yields due to reduction in rainfall and increased temperatures.

7. Adverse effects on many ecological systems

Globally, both climate change and human economic activity threaten biodiversity, especially through impacts on marine coastal and forest environments. In South Asia, deforestation and pollution of water resources have already devastated much of Sunderban's rich biodiversity.

As a result of all these factors, climate change could undermine the achievement of many of the Millennium Development Goals (MDGs), including those on poverty eradication, child mortality, malaria, and other diseases and environmental sustainability. Much of this damage would come in the form of severe economic shocks. In addition, the impacts of climate change will exacerbate existing social and environmental problems and lead to migration within and across national borders.

BANGLADESH

Bangladesh is located in a vulnerable



geographical region. It has a high population density and low levels of development and poor economic strength, which tend to make the country particularly vulnerable to climate changes. The economic losses resulting from the environmental impacts are equivalent to more than 4% of Bangladesh's GDP. Among these impacts, three sources of environmental degradation are currently receiving insufficient attention: 1) indoor and urban air pollution 2) the degradation of water quality in Dhaka and 3) the decline in capture fisheries.

Temperatures in Bangladesh increased about 1°C in May and 0.5°C in November over the past ten years and it is expected to increase further. Significant changes are taking place in rainfall patterns in the form of a shorter monsoon season or more intense rainfall when it comes. This has simultaneously created droughts and floods in different parts of the country. In addition it has also resulted into massive soil erosion lending the soil to further degradation.

The 4th IPCC report indicates that Bangladesh is slated to lose the largest amount of land globally – approximately 1,000 square km of cultivated land – due to sea level rise. It is expected that many will lose their homes and retreat to the border looking for avenues to enter, exacerbating an already tense situation

not only in the States contiguous to Bangladesh but in cities as far off as Mumbai and Delhi.

However, it should be noted that as Bangladesh has already been tackling with the natural disasters for a long time, it has developed a wealth of experience in community-based adaptation and disaster risk reduction strategies and practices, with very active contribution from civil society organisations., which have build their body of knowledge based on local people's experience and knowledge about global climate change and vulnerability when specific impacts such as floods, cyclones, saltwater intrusion, and water scarcity are addressed.

Agricultural production

The economy of Bangladesh is still largely based on agriculture and it agriculture continues to be the main source of livelihood for majority of the population. More than 62% of people from Bangladesh directly or indirectly rely on the agriculture sector, which consequently also employs 52% of the labour force. Climate change is a major threat to agricultural production and food security. The main impacts include rising temperatures, changes in rainfall and more extreme events like floods and droughts. Temperature and rainfall changes have already affected crop production in many parts of Bangladesh and the area of arable land has decreased significantly. A shrinking winter season is resulting in decreased production of winter crops, particularly potatoes. Coastal areas of Bangladesh are also very fertile and used for growing rice. The intrusion of saltwater from storm surges or sea-level rise will have serious implications for the quality of the soil and therefore, for agricultural systems in these coastal regions.

Changes in temperature and rainfall have increased water availability and have affected production of major crops like rice. A study by the International Rice Research Institute (IRRI) showed that night-time increases of 1°C during the growing season reduced global rice yields by 10%. Another study showed that the production of rice and wheat could fall by eight per cent and 32% respectively by the year 2050. Further temperature increases will lower crop production, putting stress on national food security.

Whilst farmers and local people may not understand the science of climate change, they have observed changes in seasons and rainfall patterns. They have noticed that planting seasons have shifted and that seasons are shorter than before. These changes have major implications for agriculture. They also commented that heat waves are damaging crops, livestock and fisheries. Due to changes in rainfall, planting times come earlier or are sometimes delayed. The farmers are meeting their planting needs through collecting deep tube well water. Even in the rainy season, farmers face the same problem. Due to a shortage of rainfall the paddy or other crops are not growing properly and as a result, crop production is reduced. Due to heavy rainfall or flooding the farmers are losing crops or facing large damage. If planting and harvesting is delayed due to floods it reduces crop yield for summer varieties of seed and delays winter crop planting.

Water availability

Bangladesh has huge water resources, with numerous rivers and wetlands on its surface and vast quantities of groundwater. However, climate change has altered seasonal water flow to the rivers, resulting in increased intensity of floods and droughts, brought on by changes in rainfall and temperature. It has

put tremendous stress on the availability of fresh water for both domestic and agricultural use during the dry season.

Frequency of flooding has also increased due to changed rainfall pattern (heavy rainfall) or and water coming from surrounding countries such as India. Bangladesh is also known for the cyclones that cause huge damage and flooding in coastal areas. According to the IPCC, the frequency of cyclone formation in the Bay of Bengal has declined since 1970 but the intensity of the cyclones is increasing. Government initiatives to build cyclone shelters and establish early warning systems have meant fewer lives have been lost, but more efforts are needed.

Climate change and health

Extreme events such as floods, droughts and cyclones have affected the health of people in Bangladesh in a major way. Whilst the number of deaths directly resulting from a disaster is well known, it is people's increased vulnerability post-disasters which are an equally significant cause of concern. Incidences of malaria have dramatically increased in the last 30 years, and it has become a major public health problem now. As per the official figures, out of 64 districts, 13 are classified as being in a high-risk malarial zone. Other diseases like diarrhoea, skin diseases, asthma, hypertension, dengue, and dysentery are also increasing, especially during the summer months. Studies suggest that climate change is likely to affect the distribution, lifecycle, and population dynamics of dengue.

Due to lack of pure drinking water there is a rise in water-borne diseases (diarrhoea, dysentery, typhoid and hepatitis A) whilst as a result of water shortage, people are suffering from skin diseases and conjunctivitis. In the

summer season, high temperatures are causing many to suffer from heat strokes.

Climate change and urban areas

The cities and towns of Bangladesh already face various environmental and developmental problems brought on by increasing populations due to migration from rural areas, a lack of compliance with national policies, inadequate utility services and few resources to address these issues. Adding climate change to the equation further aggravates the problems already burdening urban areas.

Dhaka, the capital city of Bangladesh, is one of the world's largest cities with a population of 13.1 million people living in an area of 1,353 km. Climate change affects Dhaka primarily in two ways: 1) through floods and drainage congestion and 2) through heat stress. Increasing rainfall and the melting of glaciers and snow in the Himalayas has led to more frequent flooding in Bangladesh. Water-logging and drainage congestion due to excessive rainfall and flooding from rivers during the monsoon season are already seriously damaging the city. Dhaka may also face 'heat island' problems because temperatures in the city are a few degrees higher than in surrounding areas. This is because concrete buildings retain heat, and activities such as vehicle exhaust, industry and the increasing use of air conditioning warm the air. This problem will increase in the future as more and more people are moving to the cities.

Coastal areas

Coastal areas are vulnerable to climate change in a multitude of ways. Cyclones, storm surges, drainage congestion, and sea-level rise directly affect coastal regions. Agriculture,

industry, infrastructure, livelihoods, marine resources, forestry and biodiversity, human health, and utility services will all be affected. Coastal zones are particularly vulnerable because climate change combines with the forces of sea-level rise, land subsidence, cyclones and changes in upstream discharge. Much coastal infrastructure, built on the advice of international finance institutions, has already disadvantaged poor coastal communities, and is likely to reduce their ability to adapt to climate change yet further.

Saltwater intrusion due to sea-level rise will create acute water crises in the future. Saltwater from the Bay of Bengal already penetrates 100 km or more inland up tributary channels during the dry season and this could get worse. Salinity in the freshwater channels and also in the groundwater affects agriculture, forests and biodiversity, and human health. Growing populations require ever increasing amounts of water, which will further deplete fresh-water supplies.

Gender and climate change

In Bangladesh, women are more vulnerable than men to chronic poverty due to gender inequalities in various social, economic and political institutions. Men tend to control income distribution, property, and access to credit, decision-making processes and other entitlements. Women have limited access to and control over natural resources and more importantly, are less mobile and have limited access to information. These factors exacerbate the vulnerability of women during disasters. In Bangladesh, the gender aspects of climate change therefore need extra attention. Bangladesh needs gender-sensitive climate change policies and planning if the MDGs are to be met.

Climate change induced impacts include

livelihood and food insecurity. When livelihood and security is under threat the children and women are the first and worst victims. They have increased working time and less and less food for themselves as the adult males consume most food and also use multiple sources of food (for example eating out in restaurants) where the women and children do not have access due to the lack of control over cash income of the family.

Women are the main users and carriers of water. They often have considerable knowledge about water resources, including their location, quality and reliability, restrictions on collection and acceptable storage methods. They are critical to the success of water resources development. Women and children provide nearly all household water in rural areas, both for domestic use such as drinking, cooking, bathing and washing, and for irrigating gardens and watering livestock. If water resources are nearby and of good quality, this will benefit women's crops and livestock and thus their families' food security. It will also reduce the amount of time and energy women must spend collecting, storing, protecting, and distributing water. The health of a women's immediate family would also be affected if water-borne diseases persist.

INDIA

India is a land full of geographical, climatic and socio-cultural diversity. The synergistic way in which the community interacts with the environment and natural resources has existed for centuries. However, over the past two decades, this relation has undergone a dramatic change. Through industrialisation and unchecked urbanisation, the once fine balance between man and environment has disappeared and now the environment suffers



greatly. Although India has seen phenomenal economic growth, a large proportion of the population still live in poverty. Over 250 million people live on less than US\$1 per day, making those living in the Indian subcontinent particularly vulnerable to climate change.

The Indian climate is dominated by the southwest monsoon that brings with it most of the region's rainfall. As such, India is heavily dependent on the annual monsoon rains to meet its agricultural and water requirements and also for protecting and propagating its rich biodiversity. While the total level of rainfall has shown little variation over the years, researchers have identified a tendency towards fewer, more extreme downpours. This has increased the potential for flooding by 10% and it continues to rise as global warming worsens. Intense rainfall events occurring during the monsoon can cause substantial damage to infrastructure, property, animal and people.

It is widely accepted that due to India's geographical and demographic distribution, it is likely to suffer a wide array of impacts of climate change, ranging from insecure energy and food supplies and reduced availability of fresh water to extreme weather events, such as cyclones, flooding, heat waves and droughts. The most susceptible will be the poor in both

rural and urban areas, who are more vulnerable and whose ability to recover from disasters is lower. More than one fourth of India's poorest community, many of whom are indigenous people, depend on forests for part of their livelihoods. As nearly half the country's forests have been degraded and their average productivity is a third of actual potential, the biggest losers are the very poor tribal people.

The melting of the Himalayan glaciers and water crisis

It is estimated that by 2030, the size of Himalayan glaciers could be reduced by as much as 80%, which spells catastrophic implications for water availability in India. Some of India's most important rivers such as the Ganges, Indus and Brahmaputra are fed by the Himalayan glaciers.

Take for example the Ganges, one of the greatest rivers of the Indian-subcontinent and a source of life for hundreds of millions of people. This river has been identified as one of the rivers most endangered by climate change. This is because much of the water feeding the Ganges originates from glaciers high in the Himalayas. Rising temperatures means that many of the Himalayan glaciers are melting fast and could diminish significantly over the coming decades.

In the short-term, the rapid melting of ice high up in the Himalayas causes river swelling and floods. The formation of glacial lakes from meltwater creates the very significant threat of floods leading to devastation of low lying valleys. Earthquakes are potential triggers for such outbursts. This problem is not endemic to India but Nepal, Afghanistan, Pakistan, Tibet, and China are at risks from such phenomena. In the longer-term, water flow in the Ganges could drop by two-thirds, affecting more than

400 million people who depend on it for drinking water whilst farmers would not be able to irrigate their land. A direct impact of this disruption of water flow would be an escalation of the water crisis, a major issue that the country already faces. Over the next 20 to 50 years, it is likely that India will face a severe water crisis from the higher frequency of floods and drought due to increased variability of annual monsoon rains and the unusually fast depletion of the Himalayan glaciers.

As per the IPCC report on Asia, global warming will cause the three most important rivers in India Ganga, Brahmaputra and Indus to become seasonal rivers and turning dry between monsoon rains and all this time, the Himalayan glaciers will continue their retreat. This scenario will become a reality by 2035, possibly sooner if nothing is done to stop climate change. This also means that the water tables will continue to fall and the gross per capita water availability in India will decline by over one-third by 2050 as rivers dry up, water tables decline or grow more saline. Water scarcity will in turn affect the health of vast populations, with a rise in water-borne diseases such as cholera. Other diseases such as dengue fever and malaria are also expected to rise.

Agriculture and food security

As a result of rising temperatures, crop productivity would fall substantially especially in non-irrigated land. Keeping in mind the subsistence farming that a large number of Indian households are involved with, this means an even lower caloric intake for the vast population already living on the brink of hunger. The possibility of starvation in many rural areas dependent on rainfall for their crops will rise significantly. Even those

areas that rely on irrigation will encounter an ever growing crisis of limited water availability.

The agricultural sector represents over one-third of the Indian economy, and around 60% of the population is dependent on subsistence agriculture as its primary source of income. Any effects that climate change has on agriculture will have significant impact on the lives of millions and will negatively impact the country's development. Food security is a serious threat for many. India's large rural population, which is heavily dependent on rain- and meltwater-fed agriculture, is already beginning to experience the effects of climate change. The impact of global warming on India, where almost 700 million people are dependent on agriculture, would also trigger mass migration of rural communities to urban areas in search of alternate livelihoods.

According to a study done by the Peterson Institute for International Economics, India's agriculture will suffer more so than other countries. Assuming a global temperature increase of 4.4°C over cultivated areas by 2080, India's agricultural output is projected to fall by 30-40%. Widespread droughts in some Indian states and heavy flooding in many others has already contributed to food insecurity. Ironically, extreme events such as floods, droughts and cyclones are causing loss of livelihood and millions in fiscal damage every year. In a nation where the population is still on the rise, disruptions to the food supply will affect the health and livelihood of millions of people. As sea-levels rise, it is expected that 35 million refugees could flee Bangladesh's flooded delta and cross into India, putting even more pressure on an already poor healthcare sector and even poorer sanitation system. Despite this, India's response to this scenario has been wholly inadequate.

While addressing Members of Parliament in a lecture organised by the Bureau of Parliamentary Studies and Training, R K Pachauri, chairman of the IPCC states that climate change is affecting Indian agriculture unlike what 'some leaders' had claimed. According to the chairman, agriculture in the subcontinent would suffer greatly with increasing global temperatures. Mr. Pachauri was quoted as saying, "Wheat yields would fall by 5-10% with every increase of 1°C."

Health

Climate change has significant impacts on health in India, and the most vulnerable is the poor, disabled, and youngest and oldest members of the population. These groups already face limited access to health facilities and have limited disposable income to cover additional medical costs and so climate change only serves to exacerbate the problem. The range of climate change-related health impacts are diverse and include heat-related deaths, vector- and water-borne diseases, loss of life due to extreme weather events and the effects of food and water insecurity.

The health of women faces is particularly vulnerable to the effects of climate change. Various studies in India have shown that over the past decade, more women than men have suffered from premature deaths because of heat and cold waves and other climate-related extreme events. The growing public health threat will require greater emphasis on planning for health facilities. In addition, the medical community will need to increase its capacity to cope with rising demands, particularly for the most vulnerable. It is estimated that mortality due to heat-related deaths will see a climb, with the poor, the elderly and daily wage earners and agricultural workers suffering a rise in heat-related deaths.

Flora and fauna

According to the IPCC, an estimated 20 to 30% of plant and animal species in India are likely to be at increased risk of extinction if the global average temperature exceeds 1.5 to 2.5°C above pre-industrial levels. While very little is known about the full impacts of climate change on individual species, indicator species in different flora and fauna groups, which are known to have a narrow range of temperature and rainfall requirements, provide some clues into the vulnerability of the natural environment to climate change.

Critical ecosystems like deserts, grasslands, coasts and mountains are at particularly high risk. For example, a rapid-warming scenario could have a significant impact on mountain ecosystems which harbour rare and endangered plant species, including medicinal plants which are adapted to colder climates. India's extensive forests, which cover around 20% of its land area, provide vital services for biodiversity, the supply of biomass, watersheds, and the livelihoods of communities. Around 200,000 villages are located in or near forests. Climate change is likely to cause a shift in forest boundaries and forest dieback having significant implications on all communities who depend on forest resources and services.

Coastal ecosystems like the mangroves are also under threat. The Sundarbans, meaning 'beautiful jungle' in the Bengali language, is the largest mangrove forest in the world. Lying at the mouth of the Ganges River, it forms a seaward fringe of the delta which spreads across areas of Bangladesh and West Bengal. Mangrove ecosystems not only provide a rich habitat for many rare and endangered species, they also provide invaluable protection against erosion from wave action and tidal surges. Mangroves have

impenetrable, webbed roots, cushioning the impact of high tides and strong waves.

In India, various policies and strategies have been framed to integrate economic and social objectives with environmental objectives. Nevertheless, the translation of these policies into plans and programmes leaves a lot to be desired. In integrating climate change concerns into the national planning process, it is essential to identify capacity gaps, build institutions to bridge these gaps, provide adequate finance, and undertake advance research and development. The challenge now is to further identify and implement integrated development and climate strategies that address development priorities.

NEPAL

Nepal's major vulnerabilities to climate change are its water resources and biodiversity. Rainfall patterns in Nepal are also changing and intense rainfall has been difficult for people living in traditionally built flat-roofed houses made of mud and stone. Roof leakage and wall erosion are major problems, particularly for low-income families who cannot afford to repair their homes.

Forests and agriculture are at risk and human health could also be affected by climate change. For example, mosquitoes may move to higher altitudes due to warmer temperatures, carrying with them greater risk of malaria and water-borne diseases could



increase during disaster events. Climate change could increase levels of Japanese encephalitis and kala-azar.

Melting of glaciers and water problem

Glaciers are the freshwater reservoirs at the top of a mountain watershed and act as the source of many rivers that wind their way through thousands of kilometres of grazing, agricultural and forested land, and are used as a source of irrigation, drinking water, energy and industry. Hundreds of millions of people throughout China and the Indian subcontinent – most of whom live far from the Himalayas – rely on water supplied from these glaciers.

As rising temperatures in the region melt the glaciers, glacial lakes are rapidly filling with water. Many are now close to bursting – causing glacier lake outburst floods. The IPCC reports that climate change has caused 'enlargement and increased numbers of glacial lakes. Such events have devastating impacts on mountainous ecosystems and infrastructure. Out of around 2,323 glacial lakes in Nepal, 20 are potentially dangerous and when outbursts occur, the consequences are catastrophic. In August 1985, a glacier lake outburst flood caused a 10 to 15 m high surge of water and debris to flow down the Bhote Koshi and Dudh Koshi rivers for 90 km, leaving a trail of destruction behind it, including disrupting a small hydropower project. More floods and changing rainfall patterns could also affect human health, for example with changes in patterns of malaria and Japanese encephalitis.

Earlier snow melt and ensuing changes to water availability could affect hydropower infrastructure and efficiency. While Nepalese rivers can potentially provide 43,000 MW of electricity, changing rainfall patterns and timing of snow melting could reduce this potential.

Food security

As with most Asian countries, Nepal will experience a decline in food security due to changes in rainfall patterns. This will affect livelihoods, as over 80% of the population depend on agriculture. Monsoon rains have become more erratic through the years. The monsoon season now starts earlier and ends later, but July, the main paddy-planting month, is becoming drier. Without rain, the paddy cannot be planted, and late planting reduces yields. Farmers have been struggling to cope with repeated failures or low yields of paddy, the staple food in Nepal.

Threat to biodiversity

Sagarmatha National Park is an area of exceptional natural beauty, dominated by Everest (Sagarmatha), the highest peak in the world standing at 8,848 m. Several rare species, such as the snow leopard and the lesser panda, are found in the park. In 1979, the UN Educational, Scientific and Cultural Organisation (UNESCO) designated the park as a world heritage site. Unprecedented rates of glacial retreat noted by high mountain communities are threatening to wipe out this heritage. Unless urgent action is taken, many Himalayan lakes in and around the park could burst and have potentially fatal consequences to the thousands of inhabitants and destroying an irreplaceable environment.

A number of measures can be carried out to prevent outburst floods. These include strengthening lake banks and decreasing lake water volumes to safe levels. Hazard maps and installation of monitoring and warning systems can help. 'Trapping dams' that have sufficient capacity to capture the debris and dissipate the impact of the outburst can be built below vulnerable lakes to minimise damage in the event of a bursting.

PAKISTAN

Like in other countries in the region, the impact of climate change in Pakistan has also been widespread. Temperatures in Pakistan have increased since the 1970s and had significant impact on agriculture and water availability. The huge climate change impact is because of increased variability of the monsoon. In fact, many experts claim that the urgency of addressing Pakistan's environmental problems has probably never been greater. Conservative estimates presented by the IPCC suggest that environmental degradation costs the country at least 6% of GDP or about Rs 365 billion per year, and these costs fall disproportionately upon the poor.

In Pakistan, changes to the summer monsoon patterns have occurred which resulted in early or delayed monsoon rains; the rains come in short heavy bursts resulting in severe flooding, which affect densely populated areas and agricultural land. Floods in agricultural areas have led to salination, chemical contamination and in some areas massive soil erosion, all of which have affected food security.

According to Azam Khan, a Sherani tribal community elder, the summer season flash floods are now more common than in the past. The Lahar streambed which was just 12 feet wide during his grandfather's time is now about 300 feet at the same point. These floods have eroded irrigation channels and agricultural field. The decline in arable area



reduced their agricultural produce. This means that people have to purchase most of their staple food from the market. Those families who have no other source of income indulge in cutting forests and selling it as timber to earn a living and this leads to further environmental degradation. The people's options for survival are shrinking day by day.

Similarly, the locals in the Thal region of western Punjab are experiencing an expanded summer season and shorter winters. A few decades ago the region was mostly grazing land, with livestock being a major source of income for people. Large herds comprising hundreds of camels, goats and sheep roamed the massive rangelands. Agriculture was only practiced at a subsistence level and comprised mainly of cultivating traditional wheat varieties on small plots of land using water from wells. However, with the advent of the Green Revolution, increased land entitlement led to more irrigated agriculture and a drive to bring more land under cultivation. Big tracts of rangeland were cleared to make room for agriculture. In areas where canal irrigation water was made available, non-local tribes moved in and locals were left with no option but to abandon their traditional nomadic culture.

Disasters

While recent disaster trends show more frequent and massive flash flooding in some areas, other parts of Pakistan are subject to prolonged and frequent spells of drought. This increased frequency and magnitude of disasters in recent years has exacerbated the vulnerability of poor communities living in these disaster-prone areas. The recent melting of glaciers in the Himalayas and Hindu Kush cause sudden increases in river volumes resulting in flash flooding in areas not historically prone to flooding. This impacts

mountainous villages and also heavily populated downstream plains causing massive destruction to crops, shelter and lives.

During the Alpine Wetlands survey of May 2002, the elders of Broghal Valley, Chitral, Pakistan, stated that the alpine glaciers are retreating at a rate of about 20 m per annum and the increased spells of summer torrential rainfall hinders their agricultural productivity because of decreased temperatures, which usually depend on the high temperatures of June to August. The region is also facing water scarcity. Whilst melting glaciers increase river volumes, this event occurs only temporarily and is not enough to meet the needs of water-scarce areas. Many studies in Pakistan and the surrounding region that is served by glacial meltwaters have found that the longer-term impact of melting glaciers will be severe water shortages.

Climate change and urban centres

Urban centres in Pakistan are also not spared from the effects of climate change. Heavy rainfall in areas previously not prone to rainfall is increasing in occurrence, causing havoc with the lives of the people as well the civic governance system. Even large cities like Karachi and Lahore lack the infrastructure, basic services and prevention measures needed to withstand major floods. This has increasingly affected urban dwellers, with heavy rainfall damaging their livelihoods and causing injury and death. Government and other stakeholders need to understand this aspect and undertake systematic research on which areas are prone to disasters.

SRI LANKA

Prof. Mohan Munasinghe, vice-chairman of the IPCC which is an expert on energy and sustainable development says climate change

in Sri Lanka will have dire consequences on water, agriculture, health and the coast. "Already there are early signs of the impact which would assume serious proportions by 2025," he said. "But unfortunately if the developed world doesn't do anything to mitigate the impact, there's little Sri Lanka can do."

According to some experts, Jaffna, and other places in the north and eastern provinces, and Matra in the southern provinces is in danger of being submerged due to a rise in sea level rise caused by global warming. In fact, the land area which is at the focal point of the current armed conflict in Sri Lanka may not be there in a few years time if the predictions are true. Jaffna, seat of a revolt for an independent homeland for minority Tamils, lies on the northern tip of the island. Northern and eastern coastal areas, both claimed by the rebels as traditional Tamil homelands, are vulnerable to submersion as they are flatter than other coastal areas. According to Prof. Munasinghe, "A major part of Jaffna and other northern areas (of Sri Lanka) will be submerged when the sea-level rises. So people are fighting and dying over areas that may soon not be there."

The vulnerability of the north and east was highlighted during the 2004 Asian tsunami when these areas bore the brunt of the damage caused by the killer waves that hit the island, following an undersea earthquake off the coast of Indonesia's Sumatra Island.

The most frightening prospect for Sri Lanka is



in its agriculture sector. "We have done some studies with the meteorological department which show higher temperatures and less water," says Prof. Munasinghe. "This will result in paddy farming output falling by 20-30% in the next 20 to 30 years. The output will begin to drop gradually over the next few years. Sri Lanka expects that over the next two decades the sea-level will rise by half a metre with dry areas becoming drier and wet areas becoming wetter, leading to floods in some areas and drought in others. Loss of solid productivity is one of the main environmental problems in Sri Lanka and the problem of soil erosion, will be further aggravated by climate change. This will have far reaching implications for agriculture sector, among others."

Climate change will also increase the risks of malaria and chikungunya outbreaks. In the hotter areas mosquitoes will be more rampant and even move into the hilly areas. Thus the incidence of vector-borne diseases like malaria and dengue in endemic areas could increase in addition to diseases triggered by poor quality water that accompanies droughts. In the Sri Lankan situation, population shifts where the country would have a larger aging population in 20 years will exacerbate the problem since health is one area where the impact would be severely felt.

The other issue is that of equity. In the wet zone where the hill country is filled with tea bushes, the tea crop will increase making those workers well off. Whilst paddy is cultivated mostly by farmer-families in which the cost of production is much higher than the selling price, tea workers are assured of their monthly wages even if tea companies find production costs higher than selling prices. Tea is generally a profitable crop.

STEPS THAT NEED TO BE UNDERTAKEN

The importance of considering climate change

when planning, designing and implementing development activities cannot be overemphasised. For the management of climate change, a complete integrated management aspect at the global level is essential. For countries like Bangladesh, China and India that has a large population, disaster preparedness and management, soil conservation and human health sectors are areas of importance which should be prioritised.

The UK's Working Group on Climate Change and Development calls for a collective action from environmental and developmental groups and issues three major challenges:

- How to stop and reverse further global warming.
- How to live with the degree of global warming that cannot be avoided.
- How to design a new model for human progress and development that is climate proof and climate friendly and gives everyone a fair share of the natural resources on which we all depend.

Although developed rich countries should take the initiative in cutting greenhouse gas emissions, emerging Asian countries also need to contribute to climate change mitigation by implementing sustainable development policies that include putting to a halt, deforestation, and developing more energy efficient systems and a venture into renewable energy. Some of the important steps to mitigate the situation would be:

- Instead of investing in fossil fuels, energy companies and international corporations should uncompromisingly invest in renewable and sustainable energy.
- In order to cope with the changing environment, South Asian small-scale agriculture will need increased support and an approach to farming built on locally adapted crop species to boost biodiversity.

Marginal farmers require adequate support from government through various policies and research that addresses the problems that are threatening their livelihood.

- Creation of a system that combines new insights and approaches with the wisdom of traditional farming and drought-control techniques. Governments must guard against the dangers associated with clearing forests and prioritising biofuels ahead of food crops.
- Assistance should be provided to the most vulnerable groups to encourage people to stay within their community rather than migrating to a new place. In the event of a lack of other options, then their movement should be smooth and barrier free and should be facilitated with appropriate political, legal and financial help.
- It is important to map the vulnerabilities of every caste, creed, religion, gender, income group, age group across the population.
- Water conservation and river-basin management strategies need to be scaled-up. Environment-friendly water management system should be put in place.
- Genetically modified (GM) crops should be developed that can grow even in saline water, i.e. made salt-tolerant. Government must also properly regulate and monitor the growing and distribution of GM crops.

In the struggle to regain our natural heritage and resources, South Asia has to show the way to the world. While it is true that we have been the victims of climate change and any approach to moving towards climate justice would require an extraordinary amount of hard work and sacrifice on the part of developed nations, it should be noted that combating climate change is the responsibility of the global community and not just that of the major polluters. The course of sustainable development as chartered by Mahatma Gandhi should again be practised.



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