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**CHANGING CLIMATIC PATTERNS AND THEIR IMPACTS
WITH SPECIAL FOCUS ON PAKISTAN**

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ABBREVIATIONS

AEDB	Alternate Energy Development Board
CC	Climate Change
CO ₂	Carbon dioxide
COP	Conference of the Parties
ENERCON	National Energy Conservation Centre
GCISC	Global Change Impact Studies Centre
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GOP	Government of Pakistan
HKH	Hindukush Karakoram Himalayan
IPCC	Intergovernmental Panel on Climate Change
NECP	National Energy Conservation Policy
PMCCC	Prime Minister’s Committee on Climate Change
PPM	Parts Per Million
UN	United Nations
UNFCCC	United Nation Framework on Climate Change Convention

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Abstract

Earth's climate has always been changing. The ice ages of the past are examples of natural changes in earth's climate. However, it is the rate of human induced change that is of current concern to scientists. Human induced warming due to emission of Greenhouse gases (GHGs) is among the most pervasive threats to the web of life. Pakistan's contribution to GHG emission is only 0.8 percent and the country ranks 135th in global GHG per capita emission, but it has been rated as one of the most vulnerable nations to the adverse effects of climate change. The impacts of climate change include biodiversity losses, rise in the sea level, shifts in the weather patterns, changes in freshwater supply and an increase in extreme weather events such as floods and droughts as well as glacial melting and various health impacts. Major concerns are threat to food, water and energy security. Diverse ecology coupled with high levels of poverty and fragile economic base has rendered Pakistan especially vulnerable to the impacts of climate change. The unprecedented floods of July, 2010 caused by climate change variability broke all previous records of loss to life, property, infrastructure and livelihood. The cost of loss and damage is estimated to the tune of US \$ 10 billion. In addition, it created 20 million climate refugees in Pakistan in just one incident which is 10 % of the total global estimate of 200 million climate refugees by 2050. The Government has therefore launched a comprehensive rehabilitation and reconstruction programme to overcome this catastrophe.

Introduction

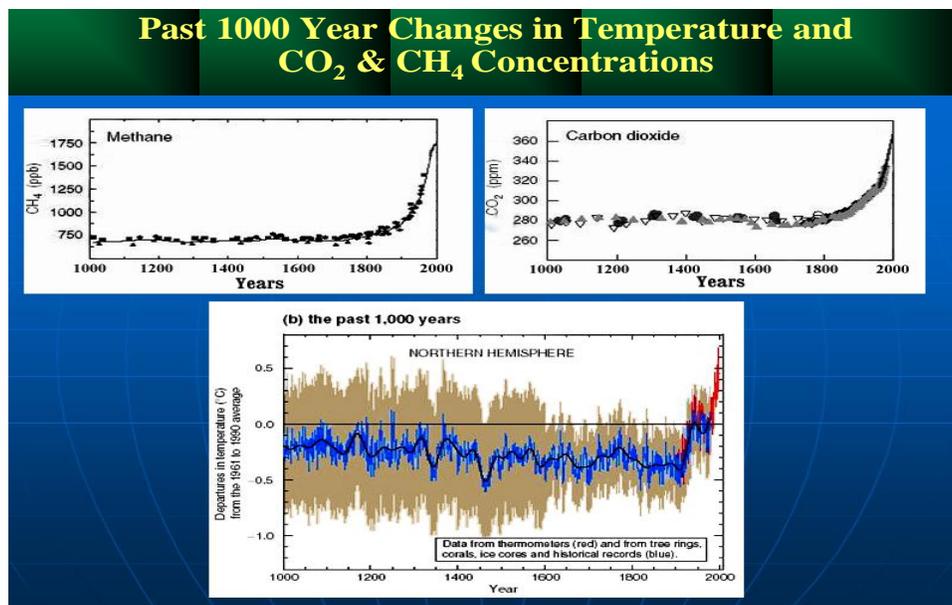
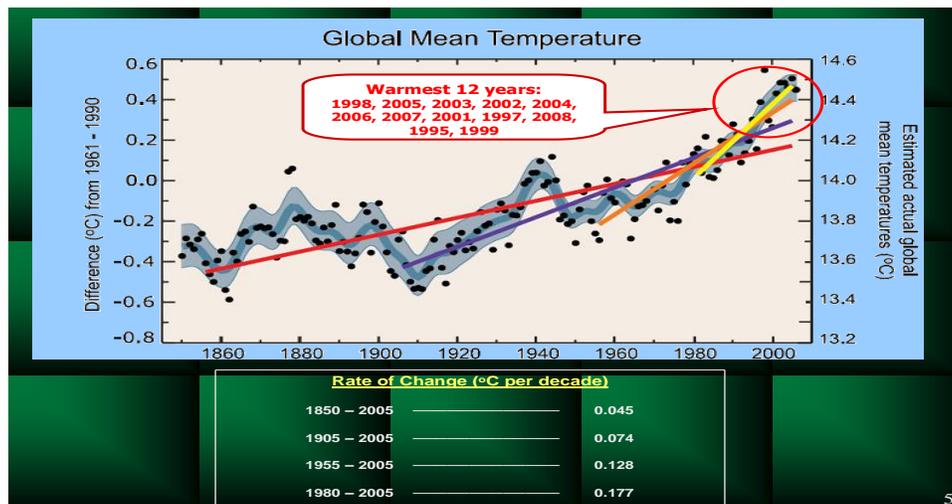
Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events). Climate change may be limited to a specific region, or may occur across the whole Earth. This paper on climate change has been divided into six sections. This brief introductory section is followed by a section on Climate Change in global perspective. The third section of the paper discusses climate change in Pakistan's perspective. The following two sections discuss Pakistan's vulnerability to climate change and the national response in terms of policy measures adopted so far. The concluding section sums up the findings of the paper.

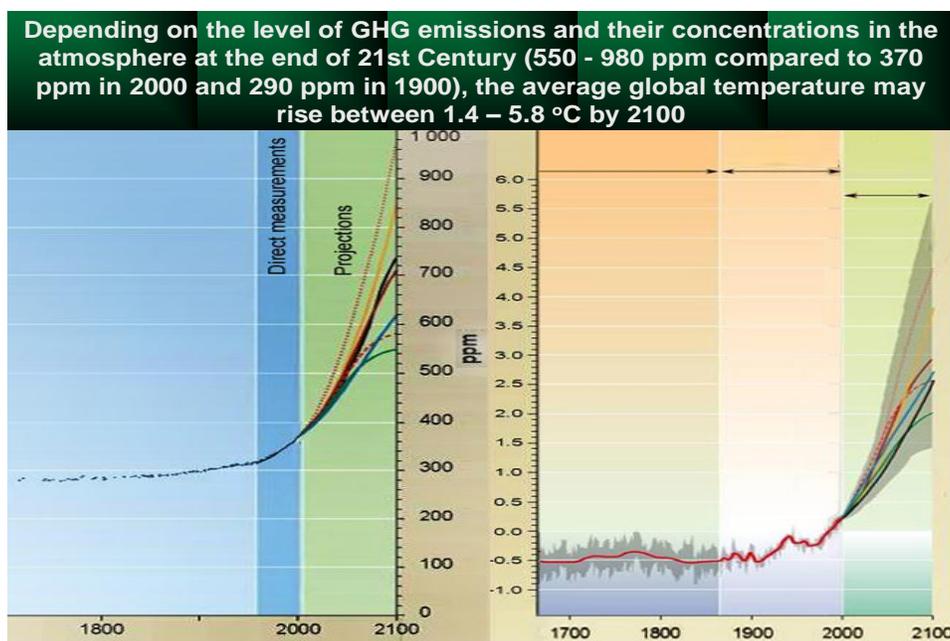
II. Climate Change: A Global Perspective:

Over the last 150 years, carbon dioxide (CO₂) concentrations in the world have risen from 280 to nearly 380 parts per million (ppm). The human activities are responsible for the increased CO₂. The CO₂ concentration has increased due to burning of fossil fuels and clearing and burning of forested land at an

unprecedented rate, thereby converting organic carbon into CO₂ and as a result the earth has been warming due to Greenhouse effect.

There is now overwhelming scientific consensus that human-induced global warming is on the increase and species and their habitats are on the decrease and chances for ecosystems to adapt naturally are diminishing. Recent incidences of temperature increases and heat waves in various regions, and/or increasing climate related natural calamities such as floods and droughts in Pakistan provide ample evidence that there is a continuous change in climate and demands serious attention in terms of both mitigation and adaptation.





III. Climate Change and Pakistan

Climate change is irrevocably harming Pakistan, with its tremendous social, environmental and economic impacts. Among the impacts felt and seen are biodiversity loss, rise in the sea level, shifts in the weather patterns, changes in freshwater supply and an increase in extreme weather events such as floods and droughts. Climate change could also affect human and animal health. The effects of global warming and climate change are relatively more pronounced in the country due to its over-reliance on the environment for basic survival, high population growth rate and density, low capacity to mitigate the negative impacts of climate change, and poverty. The poor use natural resources for their livelihoods without paying much attention to seen or unseen consequences thus limiting their livelihood assets, such as employment, health, education, and access to water and other basic amenities of life.

Pakistan's contribution to Climate Change (CC) is very little. In terms of per capita GHG emissions, it ranks 135th among the countries of the world (annual emissions was 107.5 million tonnes carbon dioxide equivalent in year 2002 which was 0.43% of world's total). However, the low carbon emission status of the country provides no safety from impacts of climate change.

According to figures used by Intergovernmental Panel on Climate Change (IPCC, 2007), 0.6 to 1.0°C rise in average temperatures since early 1900s in coastal areas of Pakistan and a 10 to 15% decrease in precipitation in coastal belt and hyper arid plains over the last 40 years have occurred.

IV. Pakistan's Vulnerability To Climate Extremes

According to a very recent vulnerability index published by a group of researchers (Maplecroft 2007), Pakistan has been rated as the 12th country most vulnerable to climate change. In economic terms, overall costs due to risks and

impacts of climate change will be equivalent to losing at least 5% of GDP each year. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more.

According to Dr. Rajendra Kumar Pachauri, Chairman of the Intergovernmental Panel on Climate Change (IPCC, 2007), Pakistan is witnessing severe pressure on its natural environment and that “Climatic changes are likely to exacerbate this trend”. Water supply will decline dramatically, affecting food production. Export industries such as fisheries will also be affected, while there are serious risks posed by inundation of coastal areas and flooding of homes of millions of people living in low-lying areas.

Extreme Climatic Events and Disasters:

A report published by Oxfam in November, 2009, titled “Climate Change, Poverty and Environmental Crisis in the Disaster-Prone Areas of Pakistan” states that 40 percent people in Pakistan are highly vulnerable to natural disasters like cyclones, floods, drought, and intense rainfall. This vulnerability is predicted to exacerbate due to impacts of climate change. There has been an increase in the incidence, frequency and intensity of extreme climatic events, including more intense and heavier rainfall that occurred as recently as 2010 and in 2009, resulting in major floods. The flood of 2010 has broken all previous records of magnitude and intensity. It affected 20 million population which is more than those hit by 2004 tsunami, 2005 earthquake disaster in Pakistan and 2009 earthquake in Haiti. The loss to property, infrastructure and livelihood is estimated to the tune of US \$ 10 billion. Before this a record 620 mm rainfall was recorded in July 2001 in Islamabad/Rawalpindi in just ten hours causing heavy urban floods in the twin cities. During the last century incidence of heavy rains occurred in 1928, 1929, 1957, 1959, 1973, 1979, 1988, 1992 and 1996. Cyclones in coastal areas have also become more intense. Droughts have also become more pronounced with the worst drought hitting the country between 1998-2001. Droughts used to appear earlier at the interval of 15-20 years but now they occur more frequently.

Historically, most heavy snowfall was recorded in 2005, which was also the warmest year on record while in 2010 the record breaking temperature occurred with unprecedented floods and heaviest rainfalls. Other extreme events of dust, thunder and hail storms, and heat waves have also been observed in recent years. Such catastrophes have resulted in loss of thousands of precious lives and damage to property and natural resources worth billions of rupees. According to a World Bank Report (2006), the country loses approximately \$4.5 billion annually from environmental disasters.

Glacial Dam burst also pose serious hazard to Pakistan due to climate change and glacial melting. On January 4, 2010, a landslide occurred in the Hunza Valley of Northern Pakistan. The initial disaster buried the village of Attabad. It also blocked the Hunza River, creating a 7-miles (11-kilometer) long lake that inundated several villages and submerged 3 miles (5 kilometers) of the Karakoram Highway. Besides displacing some 2500 people as it flooded their homes, the lake cut off

everyone between Attabad and the submerged bridge—an estimated 3,000 people. The seepage raised fears that the water might breach the Dam and flood villages downstream and its impact may reach Tarbela Dam, therefore, an artificial spill way had to be created to avoid disaster of enormous proportion. Such incidents can also occur elsewhere with fifty two such vulnerable lakes present, almost all of them located in Northern Areas of the country.

Water Sector

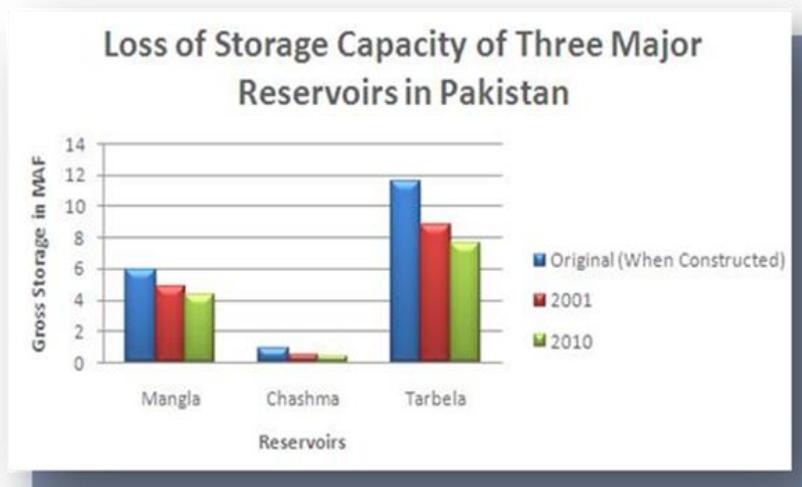
Research conducted by the Global Change Impact Studies Centre (GCISC) predicts that Western Himalayan glaciers will retreat for the next 50 years, which may later result in decrease of water flows by up to 30% to 40% over the subsequent 50 years. This is extremely serious for water and food security in Pakistan.

The major climate change related threats to water security are identified as:

- Increased variability of river flows due to increase in the variability of monsoon and winter rains and loss of natural reservoirs in the form of glaciers;
- Likelihood of increased frequency and severity of extreme events such as floods and droughts;
- Changes in the seasonal pattern of river flows due to early start of snow and glacier melting at elevated temperatures and the shrinkage of glacier volumes (this will have serious implications for storage of irrigation water and its supply for Kharif and Rabi crops);
- Increased degradation of surface water quality due to increase in extreme climate events like floods and droughts; and

Even without specific consideration of the climate change related impacts, the Planning Commission envisages that in the absence of additional storage the water shortfall will increase by 12 percent over the next decade alone (GoP-PC 2007).

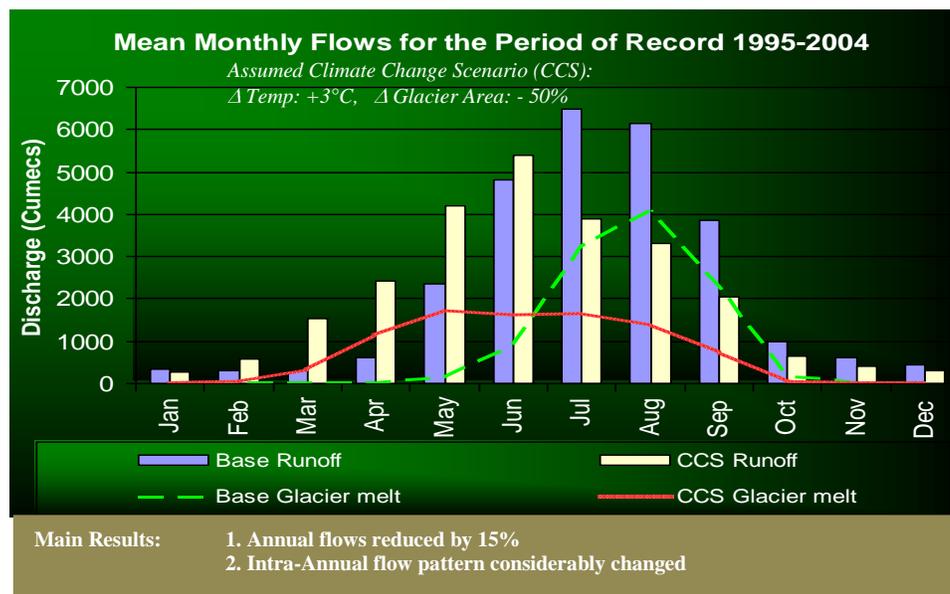
Similarly, a World Bank (WB, 2006) report stated that Pakistan is among the 17 countries that are already facing water shortages and is among the 36 countries where there is a serious threat of food crisis. Depletion of already inadequate water



storage capacity due to heavy sedimentation load has enhanced country's vulnerability to water scarcity due to climate change (GCISC^a, 2009).

Melting of Glaciers:

The Hindukush Karakoram Himalayan (HKH) glaciers represent the third largest ice mass on earth, after the Arctic/Greenland and Antarctic. Although the glaciers all over the world are found to be receding over the past century, those in the HKH region are reported to be receding faster than in any other part of the world and fears have been expressed that if the present rate of recession continues, the HKH glaciers might disappear by 2035 (Rees and Collins 2004, based on 1999 report of the International Commission on Snow and Ice; WWF 2005; IPCC 2007). The melting glaciers in the HKH are expected to increase flooding of Indus and its tributaries for the next two to three decades which will be followed by decreased river flows as the glaciers recede (IPCC 2007). The river Indus is the backbone of Pakistan's agriculture, hydroelectricity and water supply. Any disturbance to this hydrological system will have catastrophic impacts on Pakistan's social and economic life. Simulations conducted by GCISC show that with the rise in temperature and recession of glaciers, not only the flows of Indus River System will be reduced but also the pattern of its seasonal flows will be changed considerably (GCISE^a, 2009).



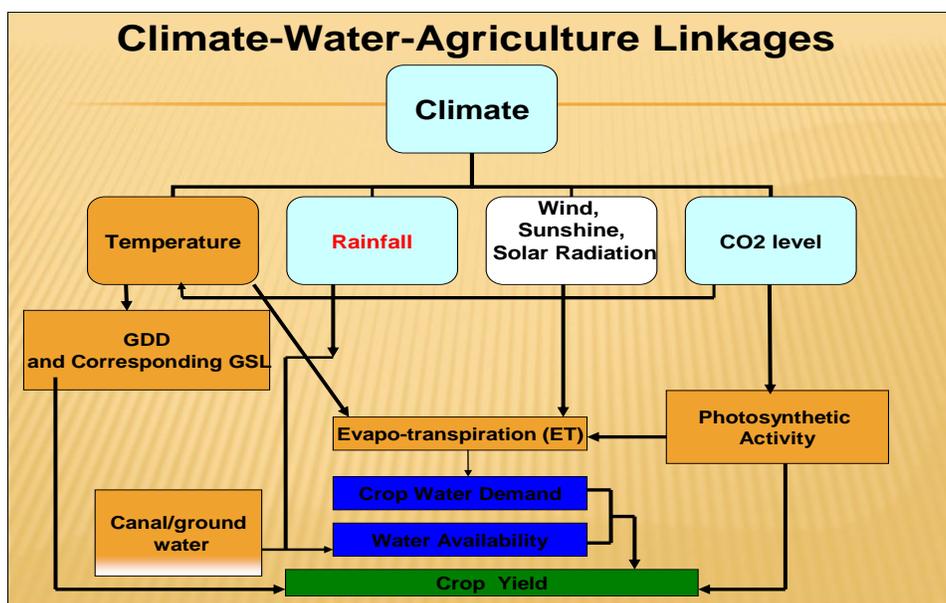
According to a study conducted by ICIMOD (2007), 5218 glaciers (15040 sq km) and 2420 lakes were identified and mapped in Pakistan. Among the identified lakes, 52 lakes have been classified as potentially hazardous, and are likely to cause Glacial Lake Outburst Floods (GLOFs) over the next few decades.

Agriculture and Livestock:

Being exposed to vagaries of nature, this sector is highly vulnerable to climate change phenomena. Pakistan is primarily an agricultural country; with

almost 65% of its population living in villages, any disturbance to the agricultural patterns is likely to have disastrous effects for the population of the country. Climate change will negatively affect agricultural productivity by altering bio-physical relationships like changing and growing periods of the crops, altering scheduling of cropping seasons, increasing crop stresses changing irrigation water requirements, altering soil characteristics, and increasing the risk of pests and diseases (TFCC, PC, 2010).

The climate change will impact the food security of the country mainly through reduced crop productivity and adverse impacts on livestock health. By mid 2020s, 2050s and 2080s growing season length of wheat will reduce respectively by 9, 16 and 23 days under B2 Scenario and, 8, 18 and 29 days under A2 Scenario of climate change. Under B2 scenario wheat and rice yield will reduce by 5% and 15% respectively while under A2 scenario wheat and rice yield will decrease by 6% and 18% by 2080s (GCISE^b, 2009).



Livestock sub sector accounts for about 11% of national GDP and accounts for half of the total productivity in agriculture sector. It will be affected by climate change in the following manner:

- Heat stress on animals will reduce the heat intake, which will adversely affect their milk and meat production.
- It will negatively affect livestock productivity by affecting fodder and rangeland productivity.
- Water scarcity and increased frequency of drought will cause animal resource loss.
- Rising temperature will also increase vector borne diseases and macro parasites of animals.

Fisheries

Climate change will also negatively affect the fisheries sub-sector through direct and indirect impacts as follows:

- Temperature changes will cause a shift in the range of fish species and their distribution.
- Warming will increase the disease transmission and also influence the marine pathogens.

Vulnerability of Coastal Areas:

Coastal areas of Pakistan are especially vulnerable to climate change due to increase in cyclonic activity resulting from rising sea surface temperatures in the Arabian Sea. The seawater intrusion upstream of the Indus delta has already reached as far as 80km upto Thatta, Hyderabad and Badin. The rise in sea level due to climate change will further inundate the deltaic region and coastal agriculture. According to National Institute of Oceanography studies, the sea level along the coast of Pakistan has been rising approximately at 1.2 mm per year since 1960. However, due to subsidence of Indus deltaic region the sea level rise may be equivalent to 2-4 mm per year and intensify the sea water intrusion upstream.

Vulnerability of land resources to desertification:

About 43 million hectare of land area in Pakistan has already been affected by desertification due to factors such as water logging, salinity, over exploitation of ground water and uncontrolled livestock grazing etc. Climate change will accelerate this process of desertification already underway, degrading agriculture and grazing land, especially in arid zone (GCISC^c, 2009).

Pakistan is already suffering from erosion damage (17% due to water erosion, 8 % due to wind erosion, 5% due to water logging and 8% due to salinity and sodicity). Climate change is likely to aggravate these categories of soil degradation processes in intensity as well as extent, thereby affecting adversely the production potential of Pakistan's agriculture. Wheat production has already dropped from 1,200-1,400kg to 880-1,020kg per hectare in five years even though there has been no change in the amount of fertilizer and quality of seeds.

Climate change will also cause enhanced landslides in mountainous areas increasing siltation loads down stream. In addition, increasing temperature and low rainfall will cause the soil moisture loss from the soils converting them to barren lands.

Energy:

Climate change will affect the energy sector directly as well as indirectly through the ripple effect from its impacts on other sectors. The main potential impacts are identified below:

- Reduction in river flow rates with consequent reduction of hydropower generation that will necessitate an increase in fossil fuel capacity and a commensurate increase in water cooling needs.
- Higher temperature will result in increased demand of energy for pumping ground water to meet higher irrigation requirements due to increased evapo-transpiration, and to compensate for water losses due to evaporation.
- Higher temperatures will increase electricity demand for space cooling, thereby increasing the peak demand and hence requiring additional generation capacity.

Biodiversity and Forest Ecosystems:

Pakistan is a home of a variety of biodiversity, which is likely to be adversely affected by climate change. It is being predicted that climate change has caused a shift in habitat from wet monsoon forest to savannah/ rangeland. A number of species of unique flora and fauna are also on the verge of extinction due to change in habitat conditions. Forestlands in northern mountain areas of Pakistan would shift from one biome to another, which would decrease in the productivity of this precious resource (TFCC, PC, 2010).

In addition, the rate of change in the values of climate parameters may be too fast to allow gradual migration of various forest tree species to neighboring areas with relatively more favorable climatic conditions. High temperature and increased precipitation would also increase forest insects, pests and weeds, which may result in greater damage to forest vegetation. As a result, the most likely impacts of climate change will be decreased productivity, changes in species composition, and reduction of forest area.

Health Impacts:

Extreme temperatures can directly cause the loss of life as warm temperatures can increase air and water pollution, which in turn harm human health. Extremely hot temperatures increase the human deaths. Other impacts include those that give rise to water and food, vector and rodent- borne diseases. For example incidence of malaria and dengue fever may increase northward with the increase in temperature and humidity. In addition incidence of pneumonia, heat stroke, cholera, and heart attack may also increase. Other viral and pollen ailments have also been reported to become more common due to increase in Pollution.

V. Pakistan's response to Climate Change

The Government of Pakistan, realizing country's vulnerability to climate change, constituted a Task Force with a view to take stock of country's situation in relation to climate change and to contribute to the formulation of National Climate Change Policy. The Task Force has completed its work and its report has been published. The Government has now embarked upon drafting the national climate change policy and development of adaptation and mitigation action plans. The draft

climate change policy has been released for soliciting comments from all stakeholders. The policy focuses on Pakistan’s vulnerability to climate change adaptation and mitigation measures, disaster preparedness, capacity building and institutional strengthening, public awareness raising, international cooperation and finance. In addition a project on “Reducing Risks and Vulnerabilities from Glacial Lake Outburst Floods (GLOF) in Northern Pakistan” has been prepared to develop human and technical capacity of public institutions to address immediate GLOF risks for vulnerable communities in Northern Pakistan.

Pakistan’s international commitments regarding climate change finds expression in its national policy frameworks such as the Medium Term Development Plan 2010-2015, One UN Programme on Environment, National Environmental Policy as well as the National Energy Conservation Policy (NECP). These documents describe clearly how the government intends to honor its international commitments on climate change.

The Government of Pakistan (GOP) has also made institutional arrangements to handle climate change issues, which among others include the Prime Minister’s Committee on Climate Change (PMCCC) and a multi stakeholder core group on climate change as well as Inter-ministerial Committee on Climate Change. The Ministry of Environment is the designated national focal point for UNFCCC and Kyoto Protocol. The Ministry has also been coordinating with other concerned agencies/institutions on various technical aspects, including the Global Change Impact Study Centre (GCISC); The National Energy Conservation Centre (ENERCON); Alternative Energy Development Board (AEDB); and Pakistan Council of Renewable Energy Technologies.

VI. Conclusion

Climate change is no longer a myth, it is a reality. Recent rains and accompanying floods that have broken 35 years record mirror the rapid and irreversible changes that are happening due to climate change. Although Pakistan contributes very little to global GHG emissions but it is being most severely affected by climate change. Therefore, the country urgently needs to protect itself from the adverse impacts of climate change. In this regard, there is a need to properly highlight the issues related to it and also promote cross-sectoral integration of climate change issues in national policies and plans. The Ministry of Environment is currently engaged in preparing climate change policy and adaptation and mitigation action plans, which would assist in reducing risks, developing robust coping strategies and creating synergies between the various government agencies and other actors responsible for environmental management and dealing with climate change issues.

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