Planning Commission
Government of Pakistan

TASK FORCE ON CLIMATE CHANGE

Final Report

February, 2010

FINAL REPORT OF THE

TASK FORCE ON CLIMATE CHANGE

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P R E F A C E

Climate change is a global phenomenon and a challenging reality for thinkers, planners, policymakers and professionals alike. It is a phenomenon that is likely to impact almost every sector of Pakistan's economy. Today it stands not only as a major environmental issue but also as a multi-dimensional developmental issue. It was in this backdrop that the Planning Commission of Pakistan set up a 'Task Force on Climate Change' (TFCC) in October 2008 to provide appropriate guidelines for ensuring security of vital resources of the country such as food, water and energy. The key task assigned to the TFCC was to contribute to the formulation of a climate change policy that would assist the government in pursuing the paramount goal of sustained economic growth by appropriately addressing the challenges posed by the climate change.

The present report is the final outcome of the TFCC effort. It is the result of 10 TFCC meetings involving extensive deliberations by the TFCC Members on various climate change related issues confronting Pakistan and draws upon the expert inputs on specific topics prepared by nine Working Groups set up by the Task Force. The report describes Pakistan's vulnerability to climate change due to impacts on various socio-economic sectors. It recommends a number of adaptation and mitigation measures based on the initial available assessment of different sectors and reviews the country's implicit ongoing and planned responses. It also provides recommendations on issues such as much needed capacity building, needs for international cooperation and Pakistan's position in international negotiations on future climate change regime. It is hoped this report will serve as a seminal document, providing a base for further work and helping the Planning Commission and the Ministry of Environment in the formulation of National Climate Change Policy and Plan of Action.

We wish to thank Mr. Salman Faruqi, former Deputy Chairman, Planning Commission for taking keen interest in the climate change issue and establishing the TFCC. We would like to acknowledge with thanks the useful contribution of the members of the TFCC and the subject experts who participated in the preparation of the inputs by various Working Groups and/or were especially invited to participate in the deliberations of the TFCC. We also appreciate the hard work put in by Dr. Arshad Muhammad Khan, Member/Secretary, TFCC and his colleagues from Global Change Impact Studies Centre (GCISC) for preparing the draft of the present report and updating it in the light of the comments of the learned Members of the TFCC. Thanks are also due to various officials of the Planning Commission, in particular Dr. Aurangzeb Khan, Chief of Environment, for facilitating efficient working of the Task Force and its associated Working Groups.

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Executive Summary

1. Introduction

Climate change resulting from an increasing concentration of Greenhouse Gases (GHGs) in the atmosphere due to the use of fossil fuels and other human activities has become a major worldwide concern. It is particularly so for Pakistan because climate change is posing a direct threat to its water security, food security and energy security. The country's vulnerability to such adverse impacts is likely to increase considerably in the coming decades as the average global temperature, which increased by 0.6 °C over the past century, is projected to increase further by 1.1 to 6.4 °C by the end of the current century.

A Task Force on Climate Change (TFCC) was set up by the Planning Commission of Pakistan in October 2008 with the view to take stock of country's situation in relation to climate change; to contribute to the formulation of a climate change policy that would assist the government in achieving sustained economic growth by appropriately addressing climate change threats so as to ensure water security, food security and energy security of the country; and to recommend policy measures for promoting large scale Adaptation and Mitigation efforts, raising awareness of various stakeholders; and enhancing the capacities of relevant national institutions.

Drawing upon the best available expertise in the country, the Task Force set up 9 Working Groups (WGs) comprising some 40 experts. Each WG headed by a TFCC member was assigned to look into some particular aspects relevant to the TFCC mandate. Based on the inputs of the above WGs and the deliberations of the Task Force in its various meetings, the TFCC Secretariat has prepared a 76-page report which takes stock of Pakistan's status as a GHG emitter, brings out its key vulnerabilities to climate change, recommends appropriate adaptation and mitigation policy measures, and highlights various ongoing and planned activities that implicitly address the issues of climate change. The report identifies main objectives for Pakistan's climate change policy, reviews the country's existing organizational structure for addressing issues of climate change, and recommends measures to improve its ability to face the challenge. It takes cognizance of the existing capacity of various national and international organizations in the country and identifies Pakistan's needs for international cooperation in terms of capacity building, technology transfer and financial support for major Adaptation and Mitigation activities. Salient points of the report are summarised here.

2. Objectives of Climate Change Policy of Pakistan

The report identifies the basic elements of Pakistan's climate change policy for the near to medium term future. Salient among those are to:

- Assist the government for sustainable economic growth by appropriately addressing the challenges posed by climate change, in particular the threats to Pakistan's water, food and energy security;
- Contribute to the international efforts to check climate change by controlling Pakistan's own GHG emissions to the maximum extent feasible;

- Help to increase the country's area under forest cover;
- Minimize the risks to the country's population and national economy arising from the expected increase in frequency and intensity of extreme events: floods, droughts, tropical storms etc.;
- Help to increase the capacity of national organizations and to make full use of new developments in science & technology for effectively addressing climate change; and
- Identify need for international cooperation and support for addressing issues of climate change.

3. Pakistan's Status as a GHG Emitter

Pakistan's total GHG emissions in 2008 amounted to 309 million tonnes (mt) of Carbon dioxide (CO_2) equivalent, comprising about 54% CO_2, 36% Methane, 9% Nitrous Oxide and 1% other gases. The biggest contributor is the energy sector with 50% share, followed by the agriculture sector (39% share), industrial processes (6% share) and other activities (5% share).

Pakistan is a small GHG emitter: It contributes only about 0.8% of the total global GHG emissions. On per capita basis, Pakistan with 1.9 tonnes per capita GHG emissions stands at a level which corresponds to about one-third of the world average, one-fifth of the average for Western Europe and one tenth of the per capita emissions in the U.S., putting it at 135th place in the world ranking of countries on the basis of their per capita GHG emissions.

4. Past and Expected Future Climatic Changes over Pakistan

During the last century, average annual temperature over Pakistan increased by 0.6 °C, in agreement with the global trend, with the temperature increase over northern Pakistan being higher than over southern Pakistan (0.8 °C versus 0.5 °C). Precipitation over Pakistan also increased on the average by about 25 %.

Studies based on the ensemble outputs of several Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase in the range 1.3-1.5 °C by 2020s, 2.5-2.8 °C by 2050s, and 3.9-4.4 °C by 2080s, corresponding to an increase in average global surface temperature by 2.8-3.4 °C by the turn of the 21st century. Precipitation is projected to increase slightly in summer and decrease in winter with no significant change in annual precipitation. Furthermore, it is projected that climate change will increase the variability of monsoon rains and enhance the frequency and severity of extreme events such as floods and droughts.

5. Major Climate Change Related Concerns

The most important climate change potential threats to Pakistan are identified as:

- Increased variability of monsoon;

- Rapid recession of Hindu Kush-Karakoram-Himalayan (HKH) glaciers threatening water inflows into the Indus River System (IRS); reduction in capacity of natural reservoirs due to glacier melt and rise in snow line;
- Increased risks of floods and droughts;
- Increased siltation of major dams resulting in greater loss of reservoir capacity;
- Severe water-stressed and heat-stressed conditions in arid and semi-arid regions, leading to reduced agriculture productivity and power generation;
- Increased upstream intrusion of saline water in the Indus delta, adversely affecting coastal agriculture, mangroves and breeding grounds of fish; and
- Threat to coastal areas including the city of Karachi due to sea level rise and increased cyclonic activity due to higher sea surface temperatures.

The above threats lead to major concerns for Pakistan in terms of its Water Security, Food Security and Energy Security. Some other climate change related concerns of Pakistan are identified as: Increase in deforestation; loss of biodiversity; increased health risks (heat strokes, pneumonia, malaria and other vector-borne diseases) and risks to other vulnerable ecosystems (e.g. rangelands, degraded lands, mountainous areas etc.).

6. Mitigation and Adaptation Measures

The Task Force report recommends a number of measures to address both Mitigation and Adaptation aspects of climate change. It also identifies various ongoing activities and planned actions envisaged under the Planning Commission's Medium Term Development Framework 2005-10 and Vision 2030 which implicitly represent Pakistan's plans and actions towards mitigation and adaptation efforts. Salient recommended as well as ongoing and planned measures are listed below:

6.1. Mitigation

Pakistan is a small GHG emitter and, like other developing countries, its emissions are bound to increase considerably as the country climbs over the development ladder and strives to provide adequate amount of energy to support its growing socio-economic developmental needs. Still, as a responsible member of the international community, Pakistan would like to contribute to the global GHG mitigation efforts without compromising on its basic minimum energy and food needs consistent with its socio-economic developmental requirements, energy security considerations, and financial and technological constraints.

6.1.1. Energy

Ongoing and Planned Actions: Energy Security Action Plan 2005-2030 envisages large roles for hydropower, renewable energy technologies (in particular, windmills), nuclear power and imported natural gas in future energy supplies; one windmill of 6 MW capacity made operational while work is underway on 18 wind power projects of 50 MW capacity each; construction of third nuclear power plant is in progress; approval given for construction of 4,500 MW Bhasha dam; agreement finalized with Iran for construction of a gas pipeline from Iran to Pakistan with capacity to transport 750 million cubic feet of gas

per day; effort being made to increase the number of vehicles using CNG as fuel from 380,000 in 2005 to 800,000 by 2010 and to 920,000 by 2015; approval given for construction of a mass transit system (circular railway) for Karachi metropolitan area; a number of projects on energy efficiency improvement, energy conservation and use of decentralized renewable energy technologies being implemented by National Energy Conservation Center (ENERCON), Water & Power Development Authority (WAPDA), Karachi Electric Supply Company (KESC), Alternative Energy Development Board (AEDB) and Pakistan Council of Renewable Energy Technologies (PCRET).

Recommended Measures**:** Energy efficiency improvement at all levels in the energy system chain; energy conservation measures and use of energy-efficient devices; rapid development of hydropower resources; large scale use of various renewable energy technologies; expansion of nuclear power programme; acquisition and adoption of clean coal technologies such as Coal Bed Methane Capture (CBMC), Integrated coal Gasification Combined Cycle power generation (IGCC), and CO_2 Capture and Storage (CCS); development of mass transit systems in large cities; and greater use of CNG as fuel for urban transportation.

6.1.2. Agriculture and Livestock

Ongoing and Planned Actions: Not much attention has so far been paid in Pakistan to address the GHG emissions from the Agriculture and Livestock sector.

Recommended Measures**:** Development and adoption of (i) new methods of rice cultivation that have lower methane emissions, (ii) new methods for reducing Nitrous oxide releases from agricultural soils, (iii) new breeds of cattle which are more productive in terms of milk and meat but have lower methane production from enteric fermentation, and (iv) new economical feeds that reduce methane production activity of cattle besides providing them with better nutrition.

6.1.3. Forestry

Ongoing and Planned Actions: It is envisaged to increase forest cover from 4.9% of the total land area in 2005 to 5.2% in 2010 and 6.0% by 2015; several afforestation projects like Rachna Doab Afforestation Project underway; tree-planting campaigns being launched each year during spring and monsoon seasons (as many as 541,176 saplings were planted in one day on 15 July 2009, which is a world record for any country).

Recommended Measures**:** Promotion of afforestation and reforestation activities to the maximum possible extent.

6.2. Adaptation

6.2.1. Water Resources

Ongoing and Planned Actions: It is planned to construct a series of large hydropower projects to add 18 MAF of new storage capacity by 2030 to the existing 12.5 MAF capacity (which is decreasing by 0.2 MAF annually due to silting); approval accorded for the construction of 4,500 MW hydropower plant at Bhasha with 6.4 MAF water storage capacity (the construction work will start in 2010); planned to complement the large storages by a comprehensive programme of small and medium dams as well as measures for recharging underground reservoirs; investigations for using groundwater aquifers as

water storage facilities; a major programme underway for lining the water channels; plans to monitor continuously the movement of glaciers in northern Pakistan.

Recommended Measures**:** Addition of sufficient reservoir capacity on IRS rivers so that even during high flood years no water flows down Kotri in excess of what is necessary for environmental reasons; local rain harvesting and building of surface and sub-surface storages for agriculture and other local needs; adoption of stringent demand management and efficiency improvement measures in all water-use sectors, particularly in the supply, distribution and use of irrigation water; reuse of marginal quality irrigation effluent.

6.2.2. Agriculture and Livestock

Ongoing and Planned Actions: It is planned to: (i) develop through biotechnology, heat-stress resistant, drought- and flood-tolerant, and water-use efficient high yielding crop varieties, (ii) increase irrigation water availability by reducing losses in the irrigation water supply network, (iii) implement "More Crop per Drop" strategy through improved irrigation methods and practices, water saving techniques in combination with the use of high yielding and water-efficient crop varieties, and (iv) increase milk and meat production by developing animals breeds which are less vulnerable to climatic changes, and by improving animal feedstock.

Recommended Measures**:** Development of new breeds of crops of high yield, resistant to heat stress, drought tolerant, less vulnerable to heavy spells of rain, and less prone to insects and pests; improvement of crop productivity per unit of land and per unit of water by increasing the efficiency of various agricultural inputs, in particular the input of irrigation water; improvement of farm practices by adopting modern techniques such as laser land levelling, crop diversification, proper cropping patterns, optimised planting dates etc; development and introduction of better varieties of livestock which would have higher productivity of milk and are less prone to heat stress and more drought tolerant.

6.2.3. Coastal Areas and Indus Deltaic Region

Ongoing and Planned Actions: It is planned to implement the recommendations of a study by local and foreign experts to identify what minimum water escapages below Kotri Barrage are required (a) to check seawater intrusion and (b) to address other environmental concerns; plans formulated to restore the degraded mangroves & marine system; major interventions are planned to boost fisheries; a major intervention underway to use brackish water for aquaculture; a National Disaster Management Authority (NDMA) established and made responsible for both disaster preparedness and disaster management in respect of all major disasters including cyclones.

Recommended Measures**:** Provision of regulated flows down Kotri to conform to minimum necessary environmental flows; restoration and protection of mangroves; construction of proper engineering structures (like dikes and seawalls) to protect beaches and other facilities along the coast; development of capacity to deal with natural disasters such as cyclones, floods, etc.

6.2.4. Forests and Other Vulnerable Ecosystems

Ongoing and Planned Actions: Besides the afforestation and reforestation activities, it is planned (a) to improve the rangelands by proper range land management, and (b) to reclaim nearly 6 million hectare of salt affected waste land and large areas of sandy desert

by growing salt tolerant, fast growing grasses, shrubs & trees to be used as fodder; it is envisaged to increase the area protected for conservation of wildlife from 11.3 % of the total land in 2004-05 to 11.6 % by 2009-10 and to 12.0 % by 2015; also planned to develop national database of threatened and endangered species and encourage captive breeding of endangered species to promote ex-situ conservation of biodiversity.

Recommended Measures**:** Aggressive afforestation and reforestation programmes with plantation suited to the looming climate change; biological control of forest pests by maintaining viable populations of predatory birds and insects through restricted use of chemical insecticide; preservation of rangelands through proper rangeland management; increase of grasslands using appropriate varieties of grass in saline and waterlogged zones to prevent their degradation; assisting genetically impoverished species or those that have important ecosystem functions by providing natural migration corridors as well as assisted migration; use of gene banks, seed banks, zoos and botanical gardens for preserving genetic diversity and conserving species out of their natural environment.

7. Organizational Structure to Address Climate Change

The report takes cognizance of the relevance, capacity and likely role of various national and international organizations operating in the country in the formulation of Pakistan's Climate Change Policy and Plan of Action and in the implementation of the corresponding activities. It then makes recommendations to improve the effectiveness of the organizational set up. Most notable among them are: (i) the Prime Minister's Committee on Climate Change may serve as the apex body for policy guidance and overview, (ii) the Ministry of Environment may be renamed as Ministry of Environment and Climate Change and provided with appropriate organizational infrastructure to reflect the increased importance of climate change in environmental issues, (iii) following the approval of the federal cabinet for establishment of Global Change Impact Studies Centre (GCISC) as an autonomous research organization under the Ministry of Environment, GCISC should now be adequately staffed and financed to serve as an effective research arm of the ministry and undertake high quality climate change related research and modelling pertaining to cross-sectoral topics, and (iv) steps should be taken by the Ministry of Environment on priority basis to formulate a formal National Climate Change Policy along with a Plan of Action as a follow up of the TFCC Report.

8. Clean Development Mechanism (CDM) Activities

It is noted that so far Pakistan's effort to take advantage of the CDM of the Kyoto Protocol for obtaining financial support and advanced technologies to reduce its GHG emissions has been lagging behind those of the neighbouring countries. The report recommends appropriate strengthening of the CDM Cell in the Ministry of Environment and its capacity building through international support.

9. Education, Communication and Awareness

The ongoing effort on communicating climate change related information to the intelligentsia as well as the general public and raising their awareness of the critical issues is found to be far below the requirements. It is recommended that such effort should be expanded very substantially making use of a variety of channels and tools such as print

and electronic media, publications, portal website, discussions and advertising, targeted dissemination of briefs, showcasing model practices, specific campaigns, etc.

10. Institutional Capacity for Addressing Climate Change

The report notes that, besides GCISC, there are several organizations in the country which could make useful contribution towards addressing climate change. It recommends: (i) capacity enhancement of all such organizations, (ii) introduction of climate change related scientific disciplines in Pakistan's leading universities so as to ensure a regular supply of trained manpower, and (iii) establishment of a National Data Bank for climatological, hydrological, agro- meteorological and other climate change related data to cater for the needs of all relevant institutions.

11. Needs for International Cooperation

Being a developing country, Pakistan lacks technical capacity and financial resources to address climate change related issues. Following are the salient areas where it needs international cooperation and support for addressing climate change:

Mitigation Effort: Extensive use of renewable energy technologies (windmills, solar cells etc.); introduction and use of Clean Coal Technologies (e.g. CCS, IGCC, CBMC); use of advanced nuclear power technology; introduction and use of Mass Transit Systems in large cities; infrastructure development for large scale import of natural gas; increase in hydropower generation capacity; large scale afforestation and reforestation activities.

Adaptation Effort**:** Sufficient expansion of large reservoir capacity; improving efficiency of water supply and distribution in the irrigation system; development of capacity to deal with disasters like floods, droughts and cyclones; construction of structures like dikes and seawalls at strategic points on the coast.

Capacity Building: Expansion of meteorological monitoring stations in various parts of the country, in particular in the northern mountainous areas and over the Arabian sea adjoining Pakistan's coastline, to the level recommended by the World Meteorological Organization; development of a cohort of professionals in the field of climate change by getting a group of young scientists trained with the help of reputable foreign institutions in fields such as regional climate modeling, watershed modeling and crop growth simulation modeling; forecasting of seasonal and inter-annual climatic changes and extreme events; monitoring of temporal changes in glacier volumes and land cover using satellite imagery and GIS techniques.

12. International Negotiations for Future Climate Change Regime

Salient recommendations of the Task Force regarding Pakistan's position in international negotiations for a post-2012 climate change regime are: (i) Global temperature should not be allowed to exceed 2 ^{o}C, (ii) Strive for the continuation of the Kyoto Protocol, (iii) Call for deep cuts in GHG emissions by developed countries, (iv) Avoid any onerous binding GHG emission reduction obligations on Pakistan, (v) Insist that, based on the principle of equity, any cap on GHG emissions should be on a universal per capita level basis and apply equally to all countries, (vi) Project Pakistan as a responsible and constructive member of international community and seek access to advanced Carbon-free, low-Carbon

and Clean Coal technologies, (vii) Emphasize adaptation as a key priority for Pakistan, (viii) Call to define and establish vulnerability on scientific basis, (ix) Reject linkage between climate change and international trade, (x) Seek substantial increase in international funding for adaptation and call for new financial and technological mechanism, (xi) Seek approval for nuclear power as an admissible CDM technology, (xii) Continue to support the position of the G77 and China.

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1. INTRODUCTION

Global Climate Change resulting from an increasing concentration of Greenhouse Gases (GHG) in the atmosphere caused by the use of fossil fuels and other human activities is now an established phenomenon and its effects have been observed in most parts of the world including Pakistan. With continued heavy reliance of the world energy system on fossil fuels for the foreseeable future much larger climatic changes and their adverse impacts are to be expected in the coming decades. According to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), the average temperature of the earth's surface increased by 0.6 °C over the past century and is projected to increase further by 1.1 to 6.4 °C by the end of the current century (IPCC 2007). It will be accompanied by large variations (both, increases and decreases) of temperature and precipitation in different world regions, considerable worldwide increases in the frequency and intensity of extreme climatic events (floods, droughts, cyclones etc.), large scale shrinking of Arctic sea ice and recession of mountain glaciers, rise in average sea level by up to 0.6 meter etc., with serious adverse impacts on various socio-economic sectors in many parts of the world.

Pakistan is particularly vulnerable to climate change because it has generally a warm climate; it lies in a world region where the temperature increases are expected to be higher than the global averages; its land area is mostly arid and semi-arid (about 60 per cent of the area receives less than 250 mm of rainfall per year and 24 per cent receives between 250-500 mm); its rivers are predominantly fed by the Hindu Kush-Karakoram-Himalayan glaciers which are reported to be receding rapidly due to global warming; its economy is largely agrarian and hence highly climate sensitive; and because the country faces increasingly larger risks of variability in monsoon rains, large floods and extended droughts. Under the influence of all these factors the Water Security, the Food Security and the Energy Security of the country are under serious threat. Compounding these problems are the expected increased risks to the coastal areas (these include Karachi, Pakistan's largest city and the hub of its industrial activity and international trade) and the Indus deltaic region due to sea level rise and increasing cyclonic activity; to the mountainous regions due to glacier lake outburst floods (GLOFs) and land slides; to the country's scanty forests (less than 5% of the land area is under forest cover) due to forest fires as well as reduced regeneration under rapidly changing climatic conditions; to human health due to heat strokes, diarrhoea, cholera, vector borne diseases, etc.; and to human settlements due to floods and cyclones.

Although Pakistan has been rather late in realising the intensity of the climate change threat to its socio-economic development, the country is now taking this threat very seriously: A dedicated research centre (called, Global Change Impact Studies Centre, GCISC) focussing on climate change related aspects was initiated in 2003 and a high level committee chaired by the Prime Minister (called Prime Minister's Committee on Climate Change, PMCCC) was established in 2005 to provide national level policy guidelines on climate change related issues. More recently, in October 2008, the Planning Commission (PC) set up a Task Force on Climate Change (TFCC) with a view to take stock of country's situation vis-a-vis climate change; to contribute to the formulation of a climate

change policy that would assist the government in achieving sustained economic growth by appropriately addressing climate change threats so as to ensure water security, food security and energy security of the country; and to recommend policy measures for promoting large scale Adaptation and Mitigation efforts, for raising awareness of various stakeholders; and for enhancing the capacities of relevant national institutions (see Annex-A for full Terms of Reference (TOR) of TFCC and Annex-B for the list of TFCC members).

While Pakistan is highly vulnerable to the adverse impacts of climate change, its own contribution to the total global GHG emissions is a miniscule (about 0.8%) and its per capita GHG emissions correspond to about one-fifth of the average for Western Europe (IEA/OECD 2006). As such, the main thrust of the country's response to climate change is bound to be on Adaptation measures. Still, as a responsible member of the international community, Pakistan would like to contribute as much to the global Mitigation effort as it possibly can while trying to meet the country's basic minimum energy needs consistent with its socio-economic developmental requirements, energy security considerations, and financial and technological constraints.

This report is based on the work done by 9 Working Groups (WGs) that were set up by the TFCC to look into different aspects relevant to its mandate (see Annex-C for the listing of the Woking Groups and Annex-D for the names of various subject specialists consulted by TFCC and its WGs). Its main purpose is to highlight Pakistan's vulnerabilities to climate change; to recommend needed Adaptation and Mitigation actions and identify those which are currently being practised to varying extent or have been planned; to identify the needs for international cooperation in terms of capacity building, technology transfer and financial support; and to make recommendations regarding the position Pakistan might take on key climate change issues in international negotiations. Salient recommendations of the Task Force are consolidated and summarized in the last Section of the report. It may however be emphasized here that the findings and conclusions of this report have been constrained by the lack of information, facts and figures, and credible findings based on research on several aspects of climate change related issues in Pakistan. Nevertheless, it provides the essence of several months of serious deliberations by the most knowledgeable group of national experts on the subject. It should therefore serve as a seminal document while formulating National Climate Change Policy and Plan of Action.

2. OBJECTIVES OF CLIMATE CHANGE POLICY OF PAKISTAN

Pakistan's climate change policy for the near to medium term future must be in harmony with the country's vision for the economy as a whole for which the VISION 2030 document (GoP-PC, 2007) envisages a "developed, industrialized, just and prosperous Pakistan through rapid and sustainable development in a resource constrained economy by deploying knowledge inputs". Accordingly, the main objectives of Pakistan's climate change policy are identified as:

1. To assist the government in pursuing the paramount goal of sustained economic growth by appropriately addressing the challenges posed by the threat of climate change.

2. To contribute to the international effort to check climate change by controlling Pakistan's own GHG emissions to the maximum extent feasible by shifting to Low Carbon Economy without compromising on the energy needs for the country's socio-economic development or on the country's energy security considerations.

3. To ensure Water Security, Food Security and Energy Security of the country in the face of challenges posed by climate change such as melting of glaciers, increased variability of monsoons, heat stress on crops and livestock etc., by devising and implementing appropriate adaptation measures in the respective sectors.

4. To introduce and ensure Climate Change Impact Assessment (CCIA) in the scope of Environmental Impact Assessment (EIA) of all projects which are part of the sectors vulnerable to Climate Change.

5. To help improve the country's overall environment by helping to increase the area under forest cover through intensive afforestation and reforestation activities so as to raise it from a dismally low level of 5% to the desirable level of around 25% .

6. To minimize the risks to the country's population and national economy arising from expected increase in frequency and intensity of extreme events: floods, droughts, tropical storms etc.

7. To provide protection to the population and economies of the particularly vulnerable regions such as the coastal areas, rangeland, mountainous areas etc., against threats emanating from climate change (e.g. sea level rise and greater cyclonic activity in the Arabian Sea, droughts and temperature extremes affecting rangeland, GLOF etc.).

8. To make full use of the new developments in science & technology to address effectively, both, the mitigation and adaptation aspects of climate change.

9. To identify the limitations of the country's institutions for addressing climate change and help build / enhance the capacities of scientists in various organizations to effectively address climate change in all its facets: monitoring, simulation modeling, projection, impact assessment, R&D on adaptation and mitigation measures, economic impact analysis etc.

10. To encourage all major organizations to prepare their individual Climate Change Programmes, identify the environmental and Carbon emission implications of all there operations and improve their performance.

11. To ensure that the actions envisioned under the national climate change policy are in harmony with those envisaged under the national policies for other sectors (water, agriculture, energy, environment etc.).

12. To facilitate the government in making effective use of the opportunities available internationally e.g. through Clean Development Mechanism (CDM), Adaptation Fund, Global Environmental Facility (GEF) etc., for technology transfer, capacity building and financial support in order to adequately address Pakistan's needs in the areas of capacity building, mitigation and adaptation.

13. To help develop a mechanism that will enhance the understanding and awareness of climate change issues among all relevant stakeholders, including the national planners and policymakers and the general public.

14. To define Pakistan's position on key climate change issues for use in international negotiations under United Nations Framework Convention on Climate Change (UNFCCC) and other international forums.

3. PAKISTAN'S STATUS AS A GHG EMITTER

Pakistan is a very low GHG emitter: As per international comparison made by the US Department of Energy's Carbon Dioxide Information Analysis Centre (US DOE 2009, as reported at Wikipedia website) based on the data for the year 2000, Pakistan's contribution to the total global GHG emissions is a miniscule (about 0.8%) and its per capita GHG emissions stand at a level which corresponds to about one-third of the world average, one-fifth of the average for Western Europe and one tenth of the per capita emissions in the U.S. Pakistan was thus ranked at 135th place on the basis of its per capita GHG emissions without land use change and at 149th place when land use change was also taken into consideration (US-DOE 2009). If only the Carbon dioxide (CO_2) emissions from fuel combustion are considered, Pakistan's performance as a low GHG emitter is even better: Its contribution to the global CO_2 emissions from fuel combustion amounts to only 0.44%, while its per capita CO_2 emissions correspond to about one sixth of the world average, one fifteenth of the average OECD level and one twenty fifth of the emission level in the U.S. (IEA/OECD 2006). Furthermore, on the basis of per unit fuel combustion, Pakistan's CO_2 emissions stand at a level which corresponds to two thirds of the OECD emission level or that of the world as a whole (see Table 3.1).

Table 3.1: Comparison of different countries on the basis of their Per Capita Energy Consumption, Per Capita CO_2 Emissions from Fuel Combustion and Ratio of CO_2 Emissions from Fuel Combustion to Energy Consumption (based on data for 2004)

Country / Region	Per Capita Energy Consumption (toe/capita)	Per Capita CO_2 Emissions (t CO_2 /capita)	CO_2 Emissions Per Unit Energy Consumption (t CO_2/ toe)
World	1.77	4.18	2.37
USA	7.91	19.73	2.49
OECD	4.73	11.09	2.34
China	1.25	3.66	2.93
India	0.53	1.02	2.40
Pakistan	0.49	0.76	1.56
Bangladesh	0.16	0.24	1.47

Source of data: IEA/OECD (2006)

The total GHG emissions of Pakistan in 1994 (July 1993 – June 1994), as reported in the country's Initial National Communication (INC) to UNFCCC were 181.7 million tonnes of CO_2 equivalent. These are estimated to have increased to 309.4 million tonnes of CO_2 equivalent by 2008 (PAEC-ASAD 2009). The corresponding sectoral breakups for the two years are shown in Figure 3.1.

Pakistan's GHG emissions in 2008 comprised about 54% CO_2, 36% Methane (CH_4), 9% Nitrous Oxide (N_2O), 1% Carbon monoxide (CO) and 0.3% Non-Methane Volatile Organic Compounds (NMVOC) (see Table G-1 in Annex-G for comparison with 1994 situation). The emissions from the Energy sector are predominantly CO_2 (almost 90%), followed by CH_4 (about 8%); those from the Agriculture sector are essentially all CH_4 and N_2O (CH_4:

79%, N_2O: 21%). About 67% of the Agriculture sector's GHG emissions originated from the enteric fermentation in cattle (these were all in the form of Methane), while nearly 21%

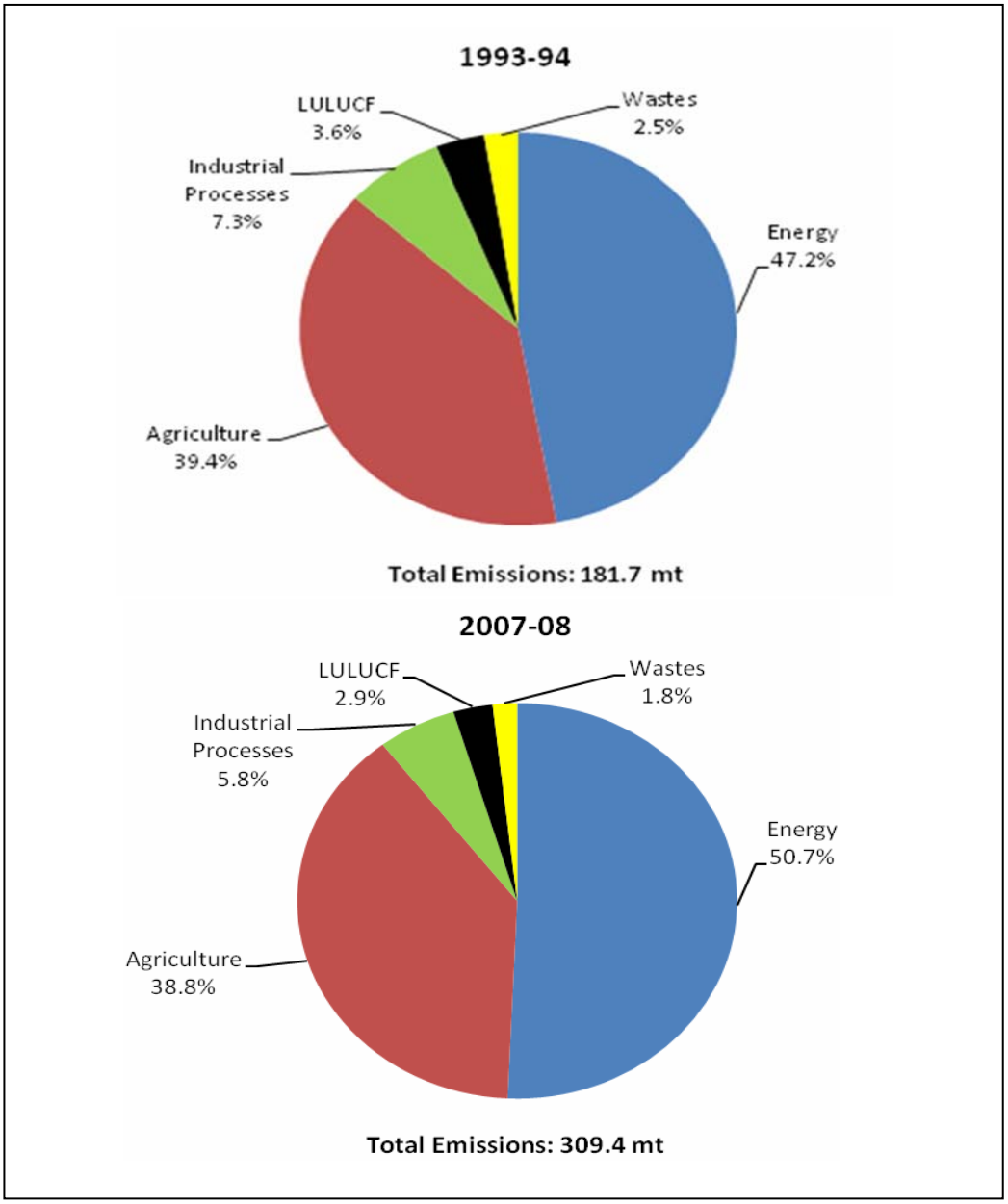


Figure 3.1: Sectoral Shares in GHG Emissions in 1993-94 and 2007-08

were due to the releases of Nitrous Oxide from agricultural soils. The share of each, Rice (paddy) cultivation and Manure management, in Agriculture sector's GHG stood at a level of about 6%. In the Energy sector, three quarters of the GHG emissions emanated from three main fuel combustion activities: Energy industries (28%), Manufacturing industries

and Construction activities (27%) and Transport (21%), while fugitive emissions from fossil fuel production / processing activities accounted for about 3% of the emissions.

Table 3.2: Inventories of Greenhouse Gases in 1994 and 2008

	1994	**2008**	**Average Annual Growth Rate**
GHG Emissions from All Sectors			
Total GHG emissions (Million tonnes of CO_2 equivalent)	181.7	309.4	3.9 %
Total GHG emissions per capita (Kilogram of CO_2 equivalent)	1541	1922	1.6 %
Total GHG emissions per 1000 US $ of year 2008 (kilogram of CO_2 equivalent)	2209	1942	-0.9 %
GHG Emissions from Fuel Sector Alone			
Total GHG emissions from Fuel Combustion Activities (Million tonnes of CO_2 equivalent)	78.9	152.1	4.8 %
Total GHG emissions per capita from Fuel Combustion Activities (Kilogram of CO_2 equivalent)	669	945	2.5 %
Total GHG emissions from Fuel Combustion Activities per 1000 US $ of year 2008 (kilogram of CO_2 equivalent)	959	955	-
Population and GDP			
Population (Million)	117.9	161.0	2.2 %
Gross Domestic Product (Billion US $ in 2007-08 prices)	82.3	159.3	4.8 %

Source of data: PAEC-ASAD (2009).

As shown in Table 3.2, during 1994-2008 Pakistan's overall GHG emissions increased on per capita basis at 1.6% per annum but decreased on per US Dollar basis at 0.9% per annum. If GHG emissions from only fuel combustion are considered, they increased at 2.5% per annum on per capita basis while remaining unchanged on per US Dollar basis.

Table 3.3: Projected GHG emissions by sector in 2020 and 2050 under Business as Usual scenario

(Mt CO_2 equiv.)

Sector	**2008**	**2020**	**2050**
Energy	157	358	2685
Agriculture	120	245	1395
Industrial Processes	18	26	67
LULUCF	9	14	38
Wastes	6	7	15
Total National Emissions	310	650	4200

Table 3.3 presents preliminary projections of GHG emissions under the Business as Usual scenario over the next four decades. These projections are based on the assumption that the elasticity of GHG emissions for each of the five main sectors (Energy, Agriculture, Industrial Processes, LULUCF and wastes) relative to GDP will remain essentially the same as during 1994-2008. It is thus projected that in line with the economic growth envisioned in the Vision 2030 document, the total GHG emissions of Pakistan will more than double by 2020 (compared to the emissions in 2008) and increase nearly 14 fold by 2050.

4. PAST AND EXPECTED FUTURE CLIMATIC CHANGES OVER PAKISTAN

4.1. Observed Trends

The studies conducted by Global Change Impact Studies Centre (GCISC 2009a) and Pakistan Meteorological Department (PMD 2009) have revealed the following trends in annual patterns of temperature and precipitation over the last century and in seasonal patterns of temperature and precipitation over the 50 year period 1951-2000:

4.1.1. Temperature

- The area averaged mean annual temperature over Pakistan increased by 0.57 °C over the period 1901-2000 (in agreement with the global trend).

- The slope of the mean annual temperature over Pakistan during the 48-year period 1960-2007 was about 0.24 °C per decade as compared to 0.06 °C per decade during 1901-2000, reflecting much increased rate of warming in recent years (again, in agreement with the global trend).

- During the period 1901-2000, the increase in mean annual temperature in the Northern part of Pakistan was higher than that for the country as a whole (0.8 °C versus 0.6 °C).

- Summer (April-May) temperatures (both mean and maximum) increased in all parts of Pakistan during 1951-2000.

- During the same period Balochistan Plateau became warmer in all the seasons.

- Monsoon (July-September) temperatures (both mean and maximum) dropped throughout Pakistan during 1951-2000 except in Balochistan Plateau.

- During 1951-2000, Greater Himalayan region (the abode of sizeable glaciers feeding the Indus River System) had a warming trend on annual basis as well as in all seasons except the monsoon season.

4.1.2. Precipitation

- The area averaged mean annual precipitation over Pakistan increased by 25% during the previous century.

- An increase in the intensity of precipitation has been observed over most areas of Pakistan during 1965-2000.

- Monsoon precipitation increased everywhere except in coastal regions (where there was a significant drop) and the Western Balochistan Plateau during 1951-2000.

- During the same period winter rains increased by 26-57% in Sub-Montane, Central & Southern Punjab, and North-Eastern Balochistan and decreased by 13-20% in Sindh and Western Balochistan.

- The Greater Himalayas region experienced the highest growth in Monsoon precipitation (86%) and a nominal decrease (2%) in winter (December-March) precipitation during 1951-2000.

4.1.3. Extreme Events

Several indices of extreme weather have shown significant trends in Pakistan. In an analysis of 17 stations during 1970-2000, 13 of the stations registered increases in daily maximum as well as daily minimum temperatures (GCISC 2009a). Durations of Hot Spells (6 or more consecutive days in which the daily maximum temperature exceeds the 90^{th} percentile) increased over Balochistan, southern Sindh and Kashmir. There are increases in the intensity of precipitation in the monsoon dominated region.

An analysis carried out for 52 meteorological stations in Pakistan for highest daily temperature and heaviest rainfall events over 24 hours during the 40-year period (1961-2000) shows (see Table 4.1) an increasing trend for decadal frequency of occurrences of such events, in particular those of highest daily temperature (GCISC 2009a).

Table 4.1: Frequency of occurrence of Highest Daily Temperature and Heaviest 1-day Precipitation events during different decades (1961-2000)

Period	**1961-70**	**1971-80**	**1981-90**	**1991-2000**
No. of stations with highest daily temperature	4	12	16	20
No. of stations with highest daily precipitation	6	18	11	17

Furthermore, extreme climatic events involving very heavy precipitation or exceptionally high temperature or those leading to floods and droughts also appear to be on the increase (see Annex-E for a list of several such events since 1990). Worth special mention is a rare cyclonic activity under which two super cyclones namely Gonu (02A) of Cat-5 and Yemyin (03B) of Cat-1 developed in the Arabian Sea during June, 2007 and hit Makran coast and adjoining countries. The history of the Arabian Sea at least during the previous century shows no such events occurring twice in a month.

A climate change phenomenon which has become a serious cause for concern over the past decade is the occurrence of dense fog in winter months around Lahore and a major part of northern Punjab. The phenomenon known as the Atmospheric Brown Cloud (UNEP 2008) is believed to be due to continental scale air pollution caused by the extensive use of coal by China and India during the course of their rapid industrialization since the early 1990s. An explanation is that in the winter months rainfall being infrequent, allows the pollutants to accumulate and react in the atmosphere to generate the pollutant fog. Several studies have documented high concentrations of sulfates, black carbon and toxic metals in air sampled in fog in Lahore (Hameed 2000; Rattigan 2002).

4.2. Projected Trends

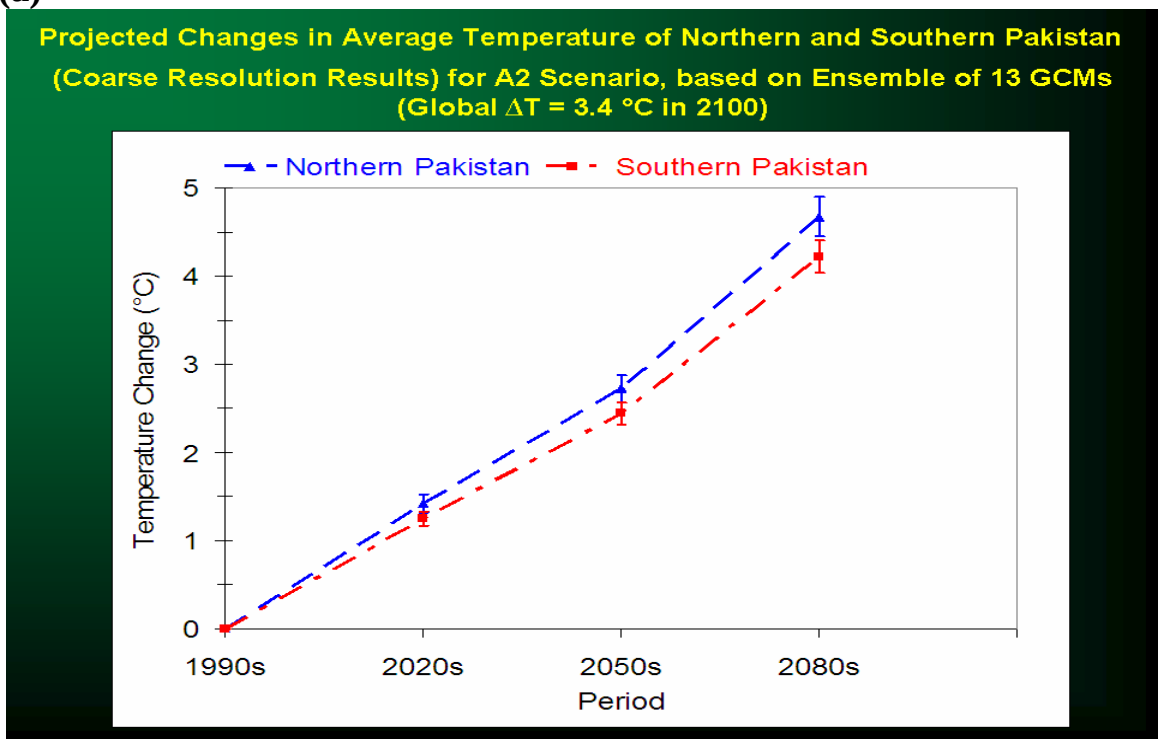
4.2.1. Temperature

The IPCC assessments based on the projection of future global climate with the help of various Global Circulation Models (GCM) predict somewhat higher temperature increases in the region where Pakistan is located as compared to average global temperature increase.

Figure 4.1 compares the projected changes in temperature in 2020s (representing average value for the period 2010-2039), 2050s (representing average for 2040-2069) and 2080s (representing average for 2070-2099) compared to the base period (1960-1990) values over Northern and Southern Pakistan (separated at 31˚ N) corresponding to the IPCC high and medium range scenarios A2 and A1B respectively (GCISC 2009b). The results are based on the outputs of ensembles of several GCMs used in the IPCC AR4 (13-GCM ensemble for the A2 scenario and 17-GCM ensemble for the A1B scenario). According to AR4, the average global surface temperature is projected to increase in A2 and A1B scenarios by 3.4 °C and 2.8 °C respectively during the 21st century. The following points are worth noting:

- As expected, the temperature increase throughout the time horizon in Northern Pakistan as well as in Southern Pakistan is higher in A2 scenario than in A1B scenario.
- In each scenario the temperature increase in Northern Pakistan is larger than that in Southern Pakistan, in line with the IPCC global scenarios which show higher temperature increase over Central Asia than that over Southern Asia.
- The temperature increase in both Northern and Southern Pakistan at the end of the time horizon in each scenario is higher than the corresponding globally averaged temperature increase (For A2 scenario, the projected temperature increases in 2080s in Northern and Southern Pakistan are 4.67 °C and 4.22 °C respectively compared to 3.4 °C average global temperature increase for 2090-2099 period relative to 1980-1999; for A1B scenario, the corresponding values are 4.12 °C, 3.73 °C and 2.8 °C respectively). The current annual average temperatures for Northern and Southern Pakistan are about 19 °C and 24 °C respectively.

(a)



(b)

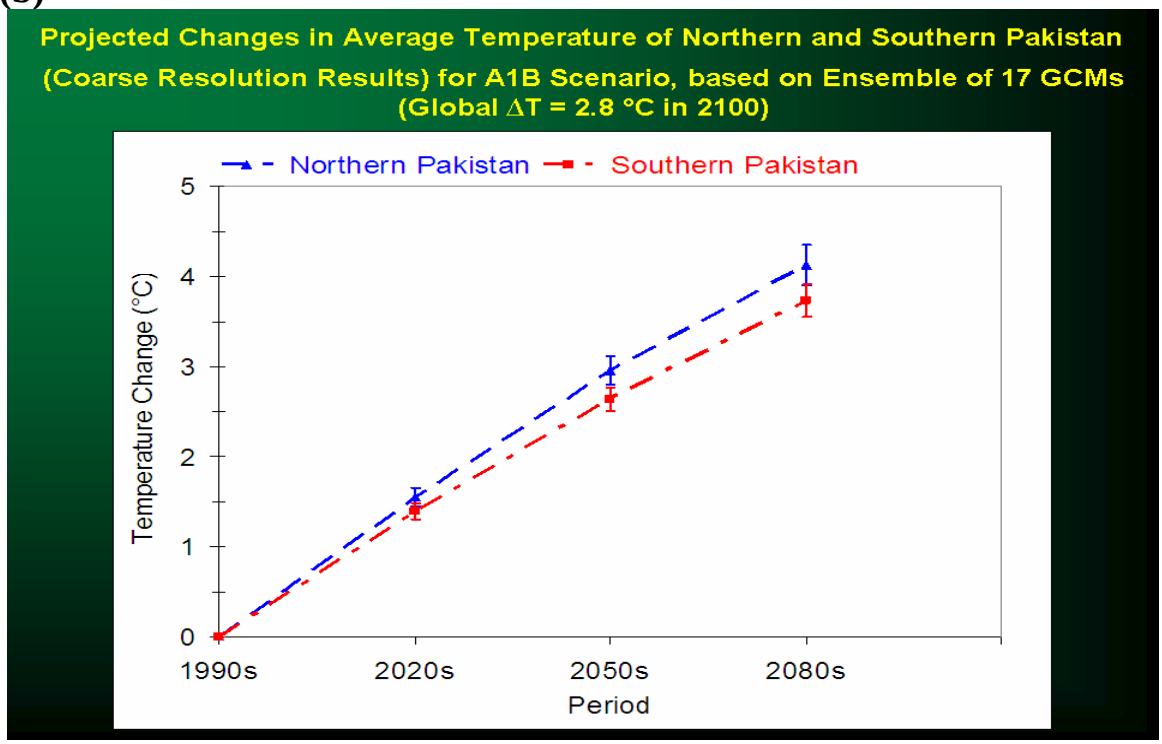


Figure 4.1: GCM Ensemble based projected temperature changes in 2020s, 2050s and 2080s over Northern and Southern Pakistan for A2 and A1B scenarios

For Pakistan as a whole the temperature increase in 2020s, 2050s and 2080s are respectively 1.31 °C, 2.54 °C and 4.38 °C in A2 scenario and 1.45 °C, 2.75 °C and 3.87 °C in A1B scenario.

Projected changes in seasonal temperature for A2 and A1B scenarios (see Table F-1 in Annex-F) show that in each scenario (i) the temperature increases in both summer and winter will be higher in Northern Pakistan than in Southern Pakistan, and (ii) the temperature increases in both Northern and Southern Pakistan will be larger in winter than in summer.

The above results are based on GCM outputs for which typically the spatial resolution is 300 km x 300 km. Projections of both temperature and precipitation changes at higher resolution are required for assessing climate change impacts at local levels. Effort is now being made by Global Change Impact Studies Centre and Pakistan Meteorological Department to obtain such projections at about 30 km x 30 km resolution by dynamically downscaling the GCM data using Regional Climate Models (RCM).

4.2.2. Precipitation

Unfortunately the GCM ensemble based precipitation projections are much less certain than those for temperature due to limitations of the current generation of Global Circulation Models for modelling precipitation. Although the precipitation projections by various GCMs vary a great deal, the analysis conducted by GCISC using the ensemble outputs of 13 GCMs for the A2 scenario and 17 GCMs for the A1B scenario indicates (GCISC 2009b) that precipitation is likely to increase in summer and decrease in winter in both Northern and Southern Pakistan, with no significant change in annual precipitation in either part (see Table F-2 in Annex-F).

4.2.3. Extreme Events

According to IPCC (2007; 2008), climate change will result in increased frequency and intensity of extreme events such as hot extremes, heat waves, heavy precipitation, droughts, tropical cyclones etc. at regional scale. In particular, the occurrences and severity of floods and droughts in the South Asian region are expected to increase with the projected increased variability of monsoon and winter rains. Likewise, the cyclonic activity in the Arabian Sea is expected to increase with the increase in sea surface temperature.

5. MAJOR CLIMATE CHANGE RELATED CONCERNS

Pakistan stands among the group of developing countries which are extremely vulnerable to the adverse impacts of climate change. The most serious concerns for Pakistan are the threats to its water, food and energy security and the vulnerability of its coastal areas. Other climate change related particular concerns include increased risks of extreme events

(floods, droughts and cyclones) and adverse impacts on forests, biodiversity, human health and vulnerable regions (mountainous areas, rangelands, arid regions etc.). Briefly discussed below are the key concerns.

5.1. Water Security

5.1.1. Water Sector: Current Status and Vulnerability

Pakistan is extremely short of fresh water resources. Under the pressure of increasing population, it became a water-stressed country (i.e. having overall per capita water availability less than 1800 cubic meters per year (m^3/y) at the turn of the century and is now heading to become a water-scarce country (per capita availability less than 1000 m^3/y by 2035 (WB 2006). Pakistan's primary sources of water are rainfall [about 50 Million acre-feet (maf) or 60 Billion cubic meters (bcm)] brought down by monsoon and westerly winds and river inflows (about 141 maf or 174 bcm) in the Indus River System (IRS) fed largely by glacier and snow melt from the Hindukush-Karakoram-Himalayas (HKH) mountain ranges. The shares of main contributing rivers to the IRS in Pakistan are: Indus: 44%, Chenab: 19%, Jhelum: 16%, Kabul: 16% and Others: 5% (see Figure 5.1). The per capita availability of river water, which was 5,650 m^3/y in 1951 and 1200 m^3/y in 2003, is expected to decline further to 1000 m^3/y in 2010 and to 800 m^3/y in 2026 under the pressure of increasing population (GoP-PC 2007). The water security of the country is therefore a very critical issue for Pakistan.

Rainfall

The annual rainfall is low and irregular, with the national average being about 278 mm, varying from around 160 mm during a dry year (e.g. 2002) to over 440 mm in a wet year (e.g. 1994), thereby contributing an average of 180 maf of rainwater over the country's total land area. The spatial variation of rainfall is also huge; it varies between 1500 mm in the northern mountainous areas and northern Punjab to less than 100 mm in the south with southern Punjab and upper Sindh getting about 150 mm per annum. About 80% of the annual rainfall occurs from July to September (the monsoon period). As Pakistan is located at the western edge of the monsoon system, heavy summer rains occur only in the northern part of the Punjab province, while the rest of the country is in a permanent state of water shortage**.** The monsoon in the Punjab is also highly variable from year to year. It is expected that climate change will enhance the variability of monsoon and winter rains.

River Flows

The average annual river inflows are about 141 maf or 174 bcm at RIM (River Inflow Monitoring) stations, varying from 97 maf in a low-flow year (2002) to 172 maf in a high flow year (1992) during the period 1977-2003. Some 82% of the water inflows are during the Kharif period (i.e. the summer months: April – September) and about 18% in the Rabi period (i.e. the winter months: October – March). The summer flows in Indus and Kabul rivers are dominated by snow and glacier melt, while those in Chenab by snow and glacier melt together with monsoon rains; Jhelum is mainly fed by snowmelt and rains from summer monsoon. The source of winter flows in all the IRS rivers is winter rainfall combined with the base flow.

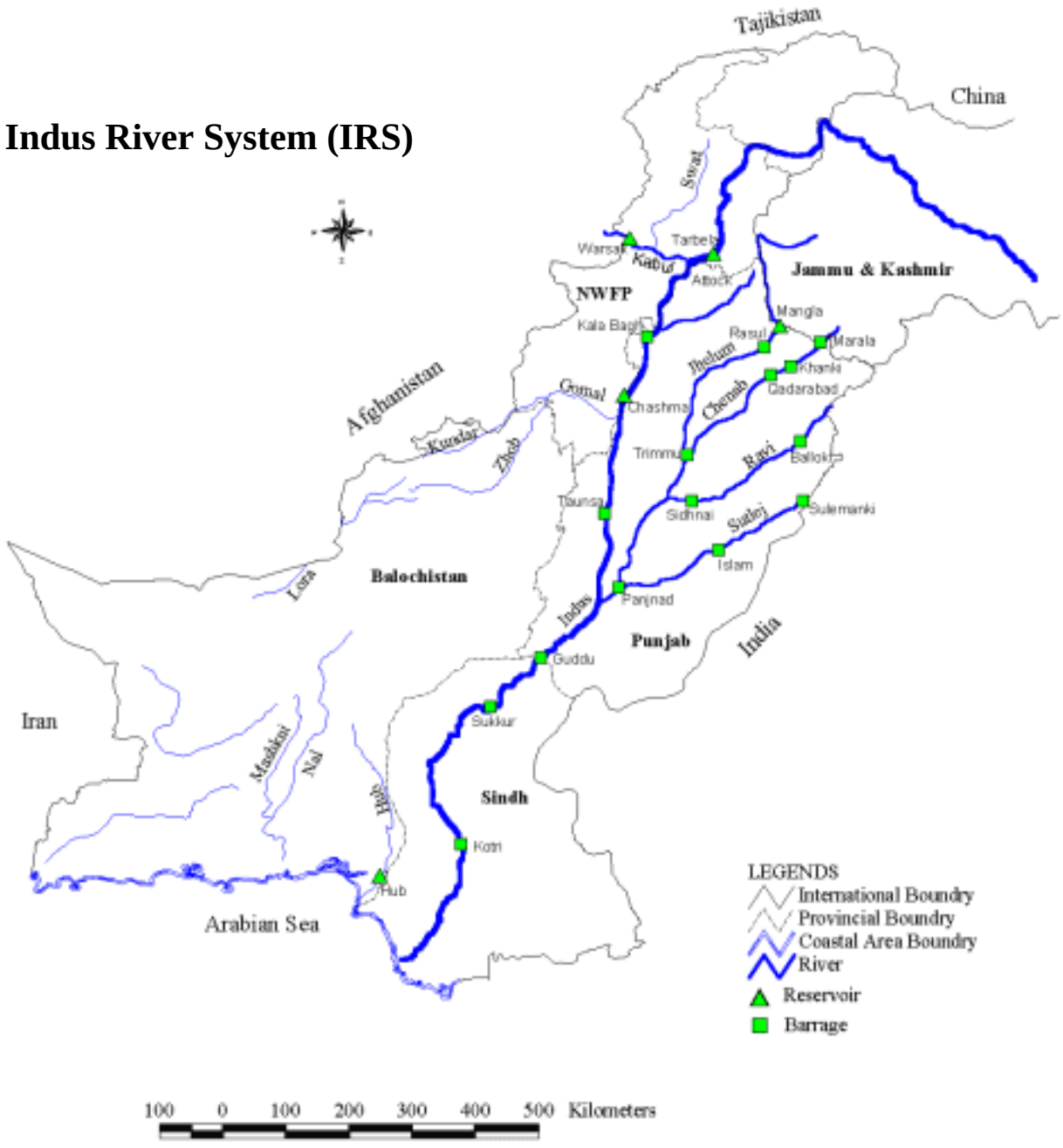


Figure 5.1. Indus River System (IRS). The water from the tributaries Ravi and Sutlej is not received by Pakistan under the Indus Basin Accord

It is expected that due to increased variability of monsoon and winter rains and the loss of natural reservoirs caused by glacier melting (see below) as a result of climate change, the inter-annual and intra-annual variability of river flows will increase and also there will be more frequent and intense occurrences of floods and droughts.

Irrigation System

Pakistan possesses the world's largest contiguous irrigation system (commonly called as Indus Basin Irrigation System) which commands an area of about 14.3 million hectares (mha) or 35 million acres representing about 76% of the cultivated area**.** The system encompasses the Indus River and its major tributaries and includes three large reservoirs (Tarbela, Mangla and Chashma). On the average about 106 maf of the river flows is diverted to the canal system. Besides the river water some 40 maf of pumped ground water is also used for irrigation. The current accountable use of water is: Agriculture: 92%, Industries: 3% and Domestic & infrastructure: 5%. In future, while the water demand by all the sectors will increase due to socio-economic development and population increase, that by the agriculture sector will increase much faster due to higher demand for irrigation water to compensate for higher evapotranspiration rates at elevated temperatures resulting from climate change. There being limited scope for expanding the supplies of water, Pakistan will have to go for improving the efficiency of water use in all the sectors, particularly in the agriculture sector.

Outflow to Sea

The average outflow to the sea (i.e. the flow below Kotri) is about 35 maf (average for 1976-77 to 2002-03 period) with the minimum flow being as low as 0.8 maf (in 2000-01) and the maximum flow as high as 92 maf (in 1994-95) (GoP-MoW&P 2005). In the low-flow years, water going to the sea is less than that necessary to prevent intrusion of sea water into the Indus deltaic region (IPOE 2005). With the rise in sea level caused by climate change, the minimum flow requirements will also go up in future.

Reservoir Capacity

Pakistan's water storage capacity comprises three large reservoirs Mangla, Chashma and Tarbela built in the years 1967, 1971 and 1974 with original capacities of 5.88 maf, 0.87 maf and 11.63 maf respectively (total original capacity: 18.37 maf). Due to silting the capacities of all the three reservoirs have been decreasing with time. The total capacity decreased to 13.68 maf in 2003 and is projected to decrease to 12.34 maf by 2010 (GoP-PC 2005). The present reservoir capacity (live storage) corresponds to only 9 percent of the IRS average annual flow and is low when compared with the corresponding figures for the world average (40 percent), India (33 percent), Nile river basin (347 percent) and Colorado river basin (497 percent) (GoP-PC 2005). Furthermore, the water storage capacity per inhabitant in Pakistan is also very low: only 150 cubic meters as compared to 2,200 cubic meters in China and 5,000 cubic meters in the U.S. and Australia (WB 2006). At present on the average 35 maf of water flows to the sea annually during flood season, while there is need to conserve every drop not required for optimal ecological flow into the sea (GoP-PC 2007). With the frequency and intensity of floods and droughts increasing as a result of climate change, there will be even greater need to store the surplus water during high river flow periods.

5.1.2. Melting of Glaciers

About 50-80% of the 141 maf average river inflows in the IRS is fed by snow and glacier melt in the Hindu Kush-Karakoram part of the HKH mountain ranges. The HKH glaciers represent the third largest ice mass on earth, after the Arctic/Greenland and Antarctic. The Hindu Kush-Karakoram mountains receive most of their precipitation during winter under westerly winds and act as a reservoir, capturing snow and rains, holding the water and releasing it in summer into the IRS, which feeds the irrigation system of the country. The Upper Indus Basin has more than 5,000 glaciers which cover a total glaciated area of about 15,000 sq. km. These glaciers correspond to about 2,700 cubic km of stored volume of ice (Roohi / ICIMOD 2005)**,** equivalent to about 14 years of average IRS inflows.

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). While reiterating its broad conclusions about the recession of Himalayan glaciers during the last century and the projected increase in their pace of recession during the 21st century, the IPCC has recently retracted its statement about the rate of recession and date for the disappearance of Himalayan glaciers (IPCC 2010).

Notwithstanding the above, there is some uncertainty about the temporal behaviour of Karakoram glaciers which have not been studied in detail because of their difficult terrain and steep slopes: While Shroder and Bishop (1999) have found that the Batura Glacier (the eighth largest mid-latitude glacier in the world) has been retreating significantly in recent years, Hewitt (2005) reports that some of the Karakoram glaciers are surging rather than receding. Hewitt's findings may possibly not be true for a vast majority of HKH glaciers as, according to PMD (2009), the thermal regime of HKH glaciated region has in general warmed up and the frequency of occurrence of moderate as well as severe heat waves has also increased significantly. Preliminary analysis of the time series data on flows of the Indus and its tributary rivers did not indicate any large melting of glaciers so far (GCISC 2009c). More detailed analysis needs to be done but it requires appropriate modeling tools together with reliable information on exact contributions of snow melt, glacier melt and monsoon components, water balance of selected catchments, disintegrating glaciers, and contributions and impacts of other hydrological variables like evapotranspiration and sub-surface flows. For the present, on the basis of bulk of the evidence, it looks most likely that the HKH glaciers are also receding under the influence of the global warming and that the melting will increase with increase in the summer temperature. This will have very serious implications for the water supply in the IRS.

The glacier melting in the Himalayas is 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 increased flow in combination with the predicted more flashy rainfall will result in frequent floods unless the reservoir capacity is

increased. The river flows are expected to decrease after a few decades due to reduced glacier mass to a level that would be determined by the precipitation input at that time. According to the World Bank (2006) report: "Pakistan's Water Economy: Running Dry", the western Himalayan glaciers will retreat for next 50 years causing increase in Indus River flows. Then the glacier reservoirs will be empty, resulting in decreases of 30% to 40% in river flows in the Indus Basin. Similarly, a three-year modelling study by the Centre for Ecology and Hydrology, Wallingford, UK and Alpine Glacier Project, University of Salford, UK covering the 100-year time horizon starting from 1991 reports that in the Upper Indus the mean river flow will increase between 14% and 90% followed by flow decreasing to between 30% and 90% of baseline by the last decade of the 21st century (Rees and Collins 2004). A recent simulation modelling study by GCISC shows that if the average temperature in the Indus watershed were to rise by 3 ^{o}C and the HKH glaciers to shrink to half their present size, not only the overall annual flow would reduce by about 15%, the monthly flow pattern would also change considerably, with more water coming in spring and early summer and less water in the later part of summer (GCISC 2009c).

5.1.3. Major Concerns

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;
- Increased demand of irrigation water because of higher evaporation rates at elevated temperatures in the wake of reducing per capita availability of water resources and increasing overall water demand;
- Increase in sediment flow due to increased incidences of high intensity rains resulting in more rapid loss of reservoir capacity;
- 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);
- Possible drastic shift in weather pattern, both on temporal and spatial scales;
- Increased incidences of high altitude snow avalanches and GLOFs generated by surging tributary glaciers blocking main un-glaciated valleys;
- The need for considerable expansion in reservoir capacity (a) to take care of the increasing frequency and intensity of floods and droughts, (b) to take advantage of the greater water flows over the next two to three decades due to glacier melting as well as to address the expected decreases of flows in the subsequent years after the glaciers have largely melted, (c) to provide regulated minimum environmental flows to the sea to prevent excessive intrusion of sea water into Indus deltaic

region, (d) to take care of the loss in reservoir capacity due to silting, and (e) to meet future increases in water demand. (Even without specific consideration of the climate change related impacts, the Planning Commission envisages that without additional storage the water shortfall will increase by 12 per cent over the next decade alone (GoP-PC 2007);

- Increased degradation of surface water quality due to increase in extreme climate events like floods and droughts; and
- Lack of current knowledge and monitoring effort on climate change impacts in the HKH region; also lack of understanding and modelling capability about the patterns of glacier melt and rainfall feeding the IRS and the corresponding impact on IRS flows.

5.2. Food Security

5.2.1. Agriculture Sector: Current Status and Vulnerability

Agriculture and Livestock sector is the mainstay of the national economy in Pakistan. It contributes 22% to Gross Domestic Product (GDP), accounts for 60% of country's exports, provides livelihood to about 68% of the country's population living in rural areas and employs 43% of the national labour force. The foremost challenge before the sector is to adequately provide for the food and fibre needs of a growing population without irreversibly damaging the fragile ecosystem. Being open to vagaries of nature, this sector is highly vulnerable to climate change phenomena. The climate change will impact the food security of the country mainly through reduced crop productivity and adverse impacts on livestock health, productivity and reproducibility as well as through increased production losses caused by extreme events (floods, droughts and cyclones).

Crop Sector

The crop sector contributes 10.5% to the national GDP (food crops: 6.6%; fibre crops: 2.5%; others: 1.3%). The main food crops are wheat and rice with respective shares of 60% and 25% in the food crop part of the GDP. Cotton is the only significant fibre crop. The total cultivated land area is about 22.2 million hectare (mha) of which some 66% is irrigated by canal water, 22% by water from tubewells and wells, and the rest simply relies on natural rainfall. Most of the farm area is divided into small sub-economic land holdings. Farmers with only 5 hectares (ha) or less land account for 86% of the farms and 44% of the farmed area of Pakistan. These small scale farmers are the most vulnerable to impacts of climate change because they lack the financial resources and access to information needed for adaptation. Furthermore, about 38% of the cultivated land in Pakistan is already suffering from environmental 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.

Crops are particularly sensitive to changes in temperature, ambient CO_2 concentration, precipitation and availability of irrigation water. Given that Pakistan has a varied type of

climate ranging from sub-zero temperatures in the north to above 50°C in the south, the impact of climate change on crops can be wide ranging. Using DSSAT (Decision Support System for Agro-technology Transfer) program including CERES-WHEAT and CERES-RICE crop simulation models, some studies have been conducted to assess the impact of climate change on the productivity of wheat crop in four different agro-ecological zones (Northern mountainous region, Northern sub-mountainous region, Southern semi-arid plains and Southern arid plains) and on Basmati rice crop in Semi-arid plains of Punjab (Sheikhupura district). It was found that the growing season length for wheat will decrease with increase in average temperature in all the agro-ecological zones in Pakistan, the rate of reduction being larger in the mountainous regions than in the arid and semi-arid plains (GCISC 2009d). For temperature increases in the range 1-5 °C, the wheat yield will increase in the mountainous region but decrease in the sub-mountainous, arid and semi-arid regions. The increase in CO_2 concentration will have a positive effect on wheat yield in all the regions due to the fertilization effect of CO_2 but it could compensate for the adverse effect of rising temperature only to a certain extent. With the increase of ambient CO_2 from the current level of 380 ppm to 550 ppm, the baseline wheat yield in the arid and semi-arid plains could be sustained for temperature increases up to 3 °C.

As for wheat, the growing season length of Basmati rice cultivated in the Semi-arid plains of Punjab is also found to decrease with rise in temperature; it will decrease from 108 days to 102 and 89 days respectively for temperature increases of 1 and 5°C over the baseline temperature (GCISC 2009e). At the current level of CO_2 concentration, the yield will have a decreasing trend with rise in temperature but increase in the CO_2 concentration level will be helpful in reducing the negative effect of temperature rise. Under the combined effect of temperature and CO_2, the baseline Basmati rice yield could be sustained for temperature increases up to 1 °C provided the ambient CO_2 concentration level were to increase from 380 to 550 ppm.

The yields of wheat and rice, the major cereal crops in Pakistan, have increased manifold since independence due to improved inputs and use of better crop breeds. The Report of the Planning Commission's Task Force on Food Security under the Chairmanship of Mr. Sartaj Aziz identifies the strategy for increasing food security of Pakistan through a variety of measures such as: (i) bridging the yield gap by increasing certified seed coverage, balanced use of fertilizer, improving water use efficiency, promoting farm mechanization and increasing live stock productivity, (ii) diversification of agriculture and value addition, (iii) post harvest management of cold chain involving processing, grading, packing, storage and transportation, (iv) protecting the rainfed agriculture through dry land technologies, (v) increasing investment in agriculture and rural infrastructure and (vi) strengthening social science research on agriculture (GoP-PC 2009).While one hopes that in future the yields will increase through the application of the above measures and at least keep pace with the growth of population, it is feared that full potential of technological improvements may not be achievable due to the adverse impacts of climate change. Simulation modelling studies at GCISC show that the national wheat production in 2080s under the influence of the climatic factors of the IPCC high and low scenarios A2 and B2

will be 6-8% lower than the potential production if the climate were to remain unchanged. Rice, the other major food crop is more sensitive to climate change; it is found that by 2080s Basmati rice production in the country will suffer a reduction of 15-18% due to climate factors anticipated under the A2 and B2 scenarios. These findings have very serious implications for the future food security of Pakistan.

One positive outcome of the above exercise is the finding that the cereal production in the northern mountainous areas will benefit from climate change. For example, the wheat yield in these areas will increase by 40-50% by 2080s under A2 and B2 scenarios. However, this will not be of much help at the national level as the contribution of the northern mountainous region to the national wheat production is merely 2%.

An increase in the frequency and intensity of precipitation events involving heavy rainfall within short periods of time is expected under the influence of climate change. Intense rainfall results in damage to crops and loss of top soil. Increased crop production losses on this account, together with those resulting from the expected more frequent and more intense floods and droughts caused by changes in average values of climatic parameters will further aggravate the food security situation of the country resulting from productivity losses.

Livestock Sector

Livestock and poultry contribute 11% to national GDP, equivalent to one half of the value added by agriculture sector. The sector's production is deeply integrated with crop production and is dominated by farmers working on small landholdings, as well as landless farmers. The livestock sector depends largely on grazing into areas of marginal productivity or rangelands which account for almost a third of Pakistan's total area. These rangelands support two-thirds of the entire population of sheep and goats and over half of the cattle population of the country.

Like the crop sector, the livestock sector is also very vulnerable to the impacts of climate change. The impacts may be direct or indirect. The direct impacts include: physiological stresses on animals due to high temperature; lower productivity of milk and meat and reduced reproduction capacity at elevated temperatures; climate-related disease epidemics; and impacts on animal habitats and environment due to climate extreme events such as floods, droughts, heavy rainfalls, hailstorms, cyclones etc. The indirect impacts include: negative impacts of climate change on productivity of fodder crops; decreased nutritional quality and palatability of forage plants due to increasing concentration of CO_2 (which alters carbon and nitrogen ratios of plants); competition for land between the fodder crops and the staple food, cash and high value crops; increased water requirements (of both fodder crops and animals); and host-pathogen interactions. The vulnerability of the livestock sector to climate change is particularly high because it depends largely on grazing into rangelands whose capacity for adaptation is very low. However, as yet, not much research has been conducted in Pakistan specifically with the view to assess climate change impacts on livestock and evaluate alternative adaptation measures.

5.2.2. Major Concerns

The major climate change related threats to food security of Pakistan are identified as:

- Reduced productivity of crops and livestock due to heat stress and other adverse impacts of changes in climatic parameters;

- Increased requirements of irrigation water due to higher evapotranspiration at elevated temperatures;

- Uncertainty in timely availability of irrigation water caused by changes in river flows due to glacier melting and altered precipitation pattern; shortage of irrigation water due to inadequate storage capacity;

- Erratic and uncertain rainfall patterns affecting particularly the rain-fed agriculture;

- Increased frequency and intensity of extreme climate events of floods, drought and cyclones resulting in heavy damages to both crops and livestock;

- Greater abundance of insects, pests and pathogens in warmer and more humid environment, particularly after heavy rains and floods;

- Degradation of rangeland and further deterioration of the already degraded cultivated land areas such as those suffering from water erosion, wind erosion, water-logging, salinity etc.;

- Intrusion of sea water into deltaic region affecting coastal agriculture;

- Lack of technical capacity to predict with reasonable certainty the expected changes in climatic parameters (temperature, precipitation, extreme events etc.) in different parts of the country, and in river flow patterns at seasonal, inter-annual and inter-decadal levels; also lack of technical capacity to fully assess, in quantitative terms, the corresponding impacts on the agriculture and livestock sector; and

- Low adaptive capacity to adverse climate change impacts due to lack of technical know how and low financial resources.

5.3. Energy Security

5.3.1. Energy Sector: Current Status and Future Needs

The primary commercial energy consumption in Pakistan in 2008 amounted to 62.9 Million tonnes of oil equivalent (mtoe), with an average growth rate of 6.0% per annum (average value for 2003-08). Besides, non-commercial fuels (fuel wood, crop residues and animal wastes) to the extent of about 20 mtoe were also used by the households and

industry. A total of 95.7 TWh of electricity were generated during the year. Figure 5.2 shows the fuel mix of primary commercial energy in 2008 while the corresponding information on electricity generation for the same year is provided in Figure 5.3.

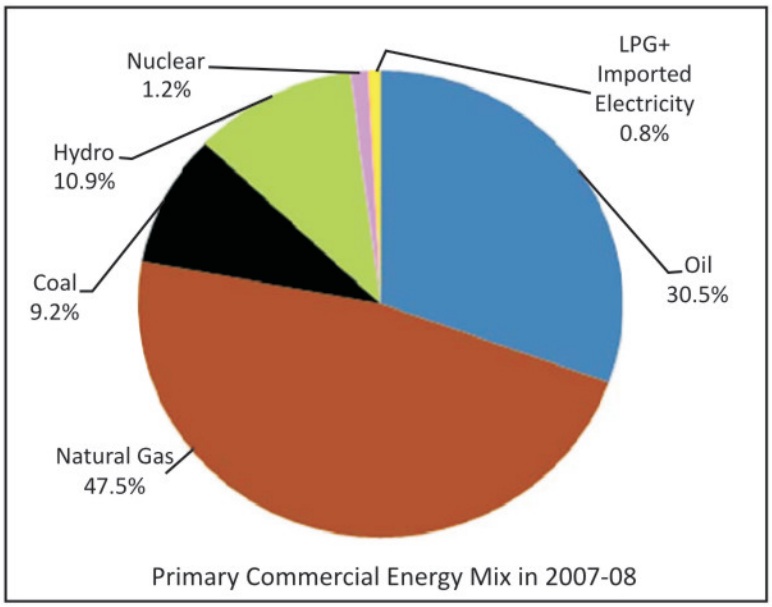


Figure 5.2: Primary Commercial Energy Mix in 2007-08

Based on historical and current trends in economic and energy growth in Pakistan, the Planning Commission envisages in its Energy Security Action Plan (ESAP) for 2005-2030 that the demand for energy will grow during the ESAP period at about 7.5-8.0 per cent per annum on the basis of a 7-8 percent sustained annual growth in GDP (GoP-PC 2007). Accordingly, the primary commercial energy demand is projected to rise 6.5 fold from about 55 mtoe in 2005 to 360 mtoe by 2030. The corresponding requirements of power generation capacity have been projected to increase more than eight fold from about 19,500 MW in 2005 to 162,500 MW in 2030 (GoP-PC 2005, 2007) (see Tables H-1 and H-2 in Annex-H). These projections are based on the assumption that GDP (in terms of constant US dollars of 2005) will increase from $109.5 billion in 2005 to $ 750 billion in 2030, while the population increase over the same period will be from 153.5 million to 230 to 260 million people. Accordingly, the per capita commercial energy and electricity consumption in Pakistan is projected to increase from 0.36 toe and 400 kWh in 2005 to about 1.5 toe and 2,000 kWh in 2030, while the corresponding change in energy intensity of the economy will be from 0.51 toe/1,000 $ to 0.48 toe/1,000 $.

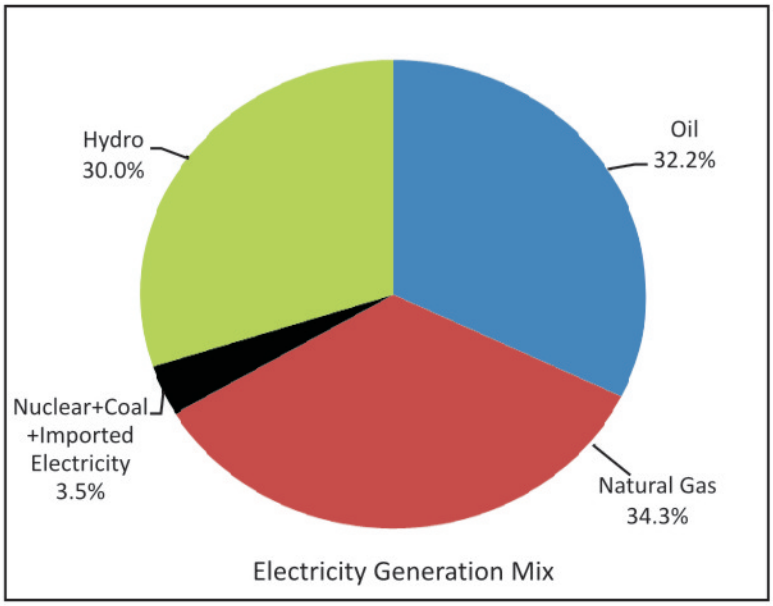


Figure 5.3: Electricity Generation Mix in 2007-08

5.3.2. Major Concerns

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

Direct Impacts

- Changes in water availability and the timing of water availability for both hydropower generation and thermal power plant cooling;
- Increased rate of sedimentation of major reservoirs resulting in reduced hydropower generation capacity;
- Reduced thermal power plant efficiency at elevated temperatures;
- Impact of changes in cloud cover, wind resources and agricultural productivity on renewable energy resources;
- Impact of sea level rise and increased cyclonic activity on existing energy infrastructure located along the coast;
- Increased Transmission and Distribution (T&D) line losses due to elevated temperatures, and increased occurrence of blackouts resulting from line sagging.

Indirect Impacts

- Reductions in river flow rates with consequent reduction of hydropower generation 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 evapotranspiration, 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.

5.4. Coastal Areas and Indus Deltaic Region

5.4.1. Current Status

Pakistan has been grouped by the UNEP's Oceans and Coastal Areas Program Activity Centre among the countries which are most vulnerable to the effects of sea level rise (GoP-MoEnv 2003). The country has a coast extending over approximately a thousand kilometres; the country's largest city, Karachi, which houses almost 10% of the total population, and about 40% of all manufacturing industry, is situated on the coast. The coastal areas are vulnerable for two reasons: rise in sea level and increased frequency and intensity of tropical cyclones.

According to the studies carried out at the National Institute of Oceanography (NIO), the sea level along the coast of Pakistan has been rising approximately at 1.2 mm per year, in agreement with the average global rise of 1.5 mm per year since 1960. The recent IPCC assessments (IPCC 2007) project 20-60 cm rise in average global sea level by the year 2100. Coastal zones and marine ecosystems, in particular Indus delta, could be damaged from increased saline water intrusion due to sea level rise and increased storm events. The NIO is of the view that the ground subsidence rates in the Indus deltaic region due to lack of sediment flux and excessive ground water extraction are probably in the range 2-4 mm per year. The ground subsidence has already resulted in the sea water intrusion upstream of the delta extending up to 80 km in the coastal areas of Thatta, Hyderabad and Badin districts (Panhwar 1999; Inam et al. 2007). The primary impacts of sea level rise on the coastal zone include the risk of erosion of beaches, flooding and inundation of wetlands and lowlands, salinization of ground and surface waters, increased intrusion of sea water into the Indus deltaic region, and adverse impact on coastal agriculture.

The Indus Delta covers approximately 600,000 ha with a coastline of 250 km, bordering the city of Karachi in the northwest. The main factor responsible for intrusion of sea water into the Indus deltaic region is an insufficient flow of Indus water downstream Kotri barrage. An average of 35 maf went downstream Kotri during the period 1976-77 to 2002-03; it varied between 0.8 maf in 2000-01 (when the IRS inflow was 103 maf) and 92 maf in 1994-95 (when the IRS inflow was 166 maf) (GoP-MoW&P 2005).

5.4.2. Major Concerns

- Climate change, through increased intrusion of sea water into the Indus deltaic region, could affect the whole range of marine life besides causing degradation of crucial ecosystems such as mangroves, coral reefs, and coastal lagoons. The mangrove forests in the Indus delta are a rich source of nutrients for a variety of marine species. They also provide breeding grounds for many varieties of coastal fish and harbour many rare plant and animal species. Mangrove ecosystems are particularly vulnerable as they are unlikely to adapt quickly enough to the changes associated with the expected range of sea-level rise e.g. reduced build up of sediment level, undercutting of roots by erosion, salt stress caused by increased salinity etc.

- In addition to its environmental impacts, sea level rise would have serious long term impacts on coastal communities, in particular threat to their food production capacity due to decline in irrigation water quality and degradation of crucial ecosystems such as mangroves and coastal lagoons. The erosion of coastal areas due to sea level rise may also tarnish the great potential Pakistan has to develop tourist resorts along the coasts. A number of prominent archaeological sites are found scattered along the coast, some of which may be under threat from temporary or permanent inundation under the influence of climate change effects (GoP-MoEnv 2003).

- Besides sea level rise, the other major threat to coastal areas arises from increased tropical cyclonic activity resulting from higher ocean temperatures. It is feared that the cyclones developed in the Arabian Sea will more often be able to penetrate into Balochistan and Sindh provinces causing loss of life and property not only in the coastal areas but also inland. Particularly under threat will be Karachi, the largest city of the country and the hub of its industry.

5.5. Forests and Other Vulnerable Ecosystems

5.5.1. Forests

The Existing forest cover in Pakistan is miserably low: Only about 4.2 million hectares or 4.8% of Pakistan's total land area is under forests, whereas the recommended level for forests is 20-25 percent of land area (GoP-PC 2005). Not only this, only about 80% of the area defined as forest in Pakistan actually has tree cover, while the rest is largely denuded (GoP/IUCN 1993). The fraction of land area under forest cover in different parts of the country also varies a great deal: Balochistan: 0.7%, Punjab: 2.8%, Sindh: 2.8%, Northern Areas: 9.5%, NWFP: 16.6%, Azad Jammu and Kashmir: 20.7%. The forests in the mountainous areas of Pakistan are degrading fast with a high rate of deforestation of 0.2 - 0.4% per annum (ADB/GEF/UNDP 1998), believed to be mainly due to illegal cutting of trees for fuelwood and timber.

Forests play a significant role in land conservation, regulation of flow of water, reduction of sedimentation in water channels and reservoirs and maintenance of ecological balance.

They also supplement the fuel needs and fulfill the timber requirements. The Forestry Sector Master Plan has estimated that the country is suffering an annual loss of 2.3 billion rupees as a result of flooding, erosion of fertile soil from upland watersheds and siltation of reservoirs and irrigation system. Yet, despite realising the pressing need to protect the existing forests and bring about significant increase in their size and despite considerable effort, it has not been possible to increase the forest cover over the last 35 years (GoP-PC 2005).

Climate change is likely to have an adverse effect on the forestry sector in Pakistan as the rate of change in the values of climate parameters may be too fast to allow gradual migration of various tree species to neighbouring areas with relatively more favourable 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.

5.5.2. Mangrove Forests

Coastal mangrove forests, which are a rich source of nutrients for a variety of marine species, extend over 132,000 hectares, representing about 3% of the forest area of Pakistan. Some 97% of these forests are located in the Indus deltaic region and the remaining 3% along the Balochistan coast. The mangrove ecosystems in Pakistan have been seriously degraded over the last 50 years as a result of inadequate flows of freshwater down Kotri, industrial and urban water pollution, and over-fishing. They will be under greater threat of destruction due to increased intrusion of sea water into the Indus delta as a result of sea level rise caused by climate change.

5.5.3. Other Vulnerable Ecosystems

Rangelands

Rangelands cover almost a third of Pakistan's total area and form an important component of its natural resources. Besides supporting two-thirds of the entire population of sheep and goats and over half of the cattle population of the country, they provide livelihood to millions of herders and pastoralists. However, there being no proper rangeland management system in Pakistan, heavy grazing pressure and utilization beyond their carrying capacity has been reducing their productivity. The rangelands in Pakistan are particularly vulnerable to the impacts of climate change because the capacity for adaptation in these impoverished regions is very low.

Degraded Lands

The main causes of large scale land degradation / desertification in Pakistan are: (i) improper land use, uncontrolled livestock grazing, and illegal removal of vegetation, (ii) Water logging, salinity and sodicity, and (iii) over-exploitation of ground water resources in the western dry mountains of Balochistan causing severe water scarcity. It is estimated that some 43 million hectares of land area has already been affected by desertification, whereas land reclamation programmes, like National Drainage Programme

would cover up to 2 million hectares only (GoP-PC 2005). Like rangelands, it is the lack of adaptation capacity in the degraded land areas which makes them very vulnerable to the adverse impacts of climate change.

Mountainous Regions

The mountainous regions of Pakistan are particularly vulnerable to climate change in view of the following: (i) more frequent formation of glacier lakes and their outbursts causing local floods (e.g. GLOFs), (ii) loosening of the frozen soil and stones, making landslides and avalanches more common, and (iii) depletion of forest resources which form an important source of livelihood for the people living in mountain areas.

Biodiversity

Pakistan is a home of a variety of biodiversity which is likely to be adversely affected by climate change. The flora and fauna as well as their habitats are already directly or indirectly being influenced by human activities which leads to their displacement and, in most severe cases, even extinction; climate change is going to exacerbate this process. According to a study by the Ministry of Environment and UNEP (GoP/UNEP 1998), 31 species of mammals, 20 of birds and 5 of reptiles are already endangered and many more are on the list of Convention on International Trade in Endangered Species of Wildlife and Fauna (CITES).

In general, climate change would affect the competitiveness of different species by differentially altering their growth and mortality rates as well as their regeneration success rates. Synchronous functioning of the life cycles of plants, animals and soil organisms will be potentially affected. Under the present unprecedented rate of climate change, a wide range of species is unlikely to adapt or migrate fast enough. Climate change in the past would have certainly caused alterations in biomes and ecosystems. However the non-availability of the required data on different aspects of biodiversity and ecosystems remains a major constraint in the quantitative analysis of the impact of climate change on biodiversity and so are the relevant techniques such as eco-climate classification and analysis through climate envelopes and profiles.

5.6. Health

Warmer temperatures and greater humidity increase the months of the year in which mosquitoes are active and thus aggravation of malaria is to be expected. This can be anticipated to be a major new hazard in northern areas of Pakistan where the mosquito season is currently limited by low temperatures in winter. Malaria is only one of the vector-borne diseases expected to expand northwards. Higher air and water temperatures are favourable to reproduction rates of many types of flies and other vectors of disease and thus an increase in infectious diseases is to be expected, particularly in the northern half of Pakistan. The recent outbreak of dengue fever in parts of Pakistan might be having its origin in the change of climate.

Various other health impacts are expected to result from the increase in extreme weather conditions caused by climate change; the most feared are: increased incidences of pneumonia, heat stokes, cholera, heart attacks etc. Another climate change related impact

of particular concern to Pakistan is the 'winter smog', which has been seriously affecting almost entire Punjab in December and January for the last several years. Believed to be due to the continental scale air pollution known as Atmospheric Brown Cloud (UNEP 2008), it is expected to increase as the use of coal and petroleum increases in India and China over the coming decades.

Climate change will not only affect human health, the overall social development would suffer form outbreak of the heat related and vector borne diseases, coupled with malnutrition caused by food and water insecurity.

5.7. Extreme Events

One of the most feared effects of climate change on Pakistan is the likelihood of increased frequency of occurrence and severity of extreme events such as floods, droughts and cyclones. Pakistan is particularly vulnerable to such events as is obvious from the large scale destruction they have caused in the recent past. For example, the floods in 1991-92 rendered agricultural growth rate for 1992-93 negative, thereby dragging overall GDP growth from 7% in 1991-92 to a mere 2% in 1992-93. Similarly, the drought during 1998-2001 affected over 3.3 million people, including thousands who became refugees and hundreds who died of thirst and starvation, and about 30 million livestock, including over 2 million that died (GoP-MoEnv 2003). Being largely an agricultural economy, Pakistan is particularly concerned about the increased risk of floods and droughts associated with climate change. Likewise, the expected increase in the tropical cyclone activity in the Arabian Sea is an issue of serious concern for Pakistan due to the fact that a large fraction of the country's industrial infrastructure is located in the coastal city of Karachi, which is quite vulnerable to the tropical cyclones generating in the Arabian Sea.

5.8. Economic Impacts

In view of the very substantial adverse impacts on various sectors likely to result from climate change, it is a major concern for the national planners and policymakers as to what will be the corresponding negative impact on the national economy as a whole. Another point of serious concern is as to how large a cost the country will have to incur on the coping mechanism, i.e. towards adaptation measures, in order to minimise the risks to key sectors: water, food, energy, coastal areas and human health, and what will be the economic value of the damage thus avoided. Yet another economic concern arises from the fact that, as a responsible member of the world community Pakistan is keen to make whatever little contribution it possibly can to the global mitigation effort, while most of the mitigation measures (see Section 6.1) are prohibitively expensive. These are not easy questions to answer but they are of crucial importance for the national planners and policymakers, who are keen to shape the country's development plans in the most optimal manner within the constraints of the limited available resources. On the initiative of TFCC, a Working Group on Economics established under the chairmanship of the Task Force member from Pakistan Institute of Development Economics) has started looking into these issues and will hopefully be able to come up with some quantitative estimates in the near future.

6. MITIGATION AND ADAPTATION MEASURES

Over the last ten years or so there has been a growing realization among the planners and policymakers in Pakistan that the country is extremely vulnerable to climate change, that climate change will have intense socio-economic impact on Pakistan in terms of human health and well being (through heat stress and diseases such as increase malaria), food security, water resources, forestry, livestock, and energy, and that comprehensive and careful studies are needed to fully understand the nature and extent of the expected climatic change, its impacts and required adaptation measures (GoP-PC 2005, 2007). In this connection the Vision 2030 document of the Planning Commission emphasizes the need "to build up the capacity for multidisciplinary studies and modeling for reliable climate forecasting and analysis of its socio economic impact" (GoP-PC 2007).

Pakistan faces yet another challenge: Although it is a very low-level GHG emitter and an insignificant contributor to total global GHG emissions it, like any other developing country, needs large increases in energy supplies to fuel its much needed socio-economic development. At the same time, the national planners and policymakers feel that, as a responsible member of the world community, Pakistan should do whatever it can to check its future GHG emissions. Therefore, a way has to be found to meet the above two objectives without compromising on the country's socio-economic development or energy security. With these realizations at the back of the mind, they have been incorporating programmes and policies in the short-, medium- and long-term development plans of the country (GoP-PC 2005, 2007) which implicitly, if not explicitly, represent Pakistan's current actions and plans towards addressing climate change on both the fronts: mitigation and adaptation. Those aspects are discussed below.

6.1. Mitigation

As discussed in Section 3, Energy sector is the single largest source of GHG emissions in Pakistan; its contribution to total emissions is nearly 51%. It is followed by Agriculture sector with around 39% share. The shares of other sectors are relatively small (Industrial Processes: 6%, Land use change, Forestry etc.: 3%, Wastes: 2%). As such, the most important targets for mitigation effort involving reduction of GHG emissions are the Energy and the Agriculture sectors.

In the Energy sector, the main candidates for such an effort are: Energy Mix, Energy Efficiency and Conservation, and Transportation Energy, while those in the Agriculture sector are Livestock and Rice (Paddy) Cultivation. Besides these, considerable mitigation potential exists in Pakistan through Carbon Sequestration via afforestation / reforestation and CO_2 Capture and Storage. Based on these opportunities, a number of effective mitigation measures are identified below. Also reviewed briefly are the ongoing and planned government actions to this effect.

6.1.1. Energy

An important characteristic of Pakistan's energy system has so far been its high reliance on natural gas (the fossil fuel with the lowest Carbon intensity) and very little use of coal (the fossil fuel with the highest Carbon intensity) in utter contrast to the patterns of primary energy consumption and electricity generation in neighbouring countries, China and India, as well as those in USA, European Union and the world as a whole (see Table H-3 in Annex-H). It is largely for this reason that the CO_2 emissions per unit of energy consumption in Pakistan are among the lowest in the world, being only about two thirds of those in India, China, USA, the OECD countries and the world as a whole (see Table 3.1). Inevitably, however, the country's energy system will have to change considerably. By now Pakistan's natural gas reserves have depleted to such an extent that even with reasonable expectation for new discoveries it will be difficult to maintain even the present level of production for long. The oil resources are dismally low; already some 85% of the oil requirements (equivalent to 29% of the total energy supply) are being met through imports, with the oil imports bill siphoning off one-third to half of the precious exports earnings (36% in 2006-07 and 57% in 2007-08). The only sizable fossil fuel resource available in Pakistan is coal with an estimated resource base of 185 billion tonnes (over 82,700 mtoe, or 2% of the world coal resources) of which 3.3 billion tonnes are measured and 2.0 billion tonnes are recoverable coal reserves. [This coal is equivalent to the combined oil reserves of Saudi Arabia and Iran (GoP-PC 2007).] Therefore, in order to keep its energy import dependence to within manageable level (at present it stands at 35% level), Pakistan has no alternative but to seek meeting an increasingly large fraction of its future energy needs through the use of its practically unutilised vast coal resources. It is hoped hat the international community will come forward to help Pakistan make use of its coal resources in a way consistent with the mitigation objectives i.e. minimal emission of GHG.

6.1.1.1. Recommended Measures

The following are identified as the key mitigation measures applicable to the energy sector in Pakistan:

- Take all necessary steps to become an active participant in the global transition to energy efficient and low Carbon world economy.

- Improve energy efficiency at all levels in the energy system chain (covering: production, transformation, transportation / transmission and end-use).

- Publicise and promote energy conservation measures and use of energy-efficient devices to reduce energy wastages.

- Promote the development and large scale use of renewable energy technologies e.g. wind, solar, small hydro, geothermal, biofuels etc., as is being done by several other developing countries such as China, India, Egypt, Malaysia etc. (Gross wind power potential in Sindh province alone has been estimated as 50,000 MW with

capacity factors in the range of 23-28 per cent; the solar potential for most parts of Pakistan lies in the range 150-300 KWh /m^2/year.)

- Offer appropriate incentives to those who opt for energy efficiency improvement and conservation measures and impose suitable penalties on those who don't.

- Expand large scale hydropower generation to the extent technically and economically feasible and socio-politically acceptable. (Only about 14% of the available 46,000 MW hydropower potential has so far been developed.)

- Increase the use of nuclear power, a Carbon-free source, keeping in view the level of global reliance on this technology, trends in the neighbouring countries, and Pakistan's energy security considerations.

- Acquire and adopt clean coal technologies such as Coal Bed Methane Capture (CBMC) technology, Integrated coal Gasification - Combined Cycle power generation (IGCC) technology (involving, both, in-situ and mine-mouth gasification) and CO_2 Capture and Storage (CCS) technology in order to allow large scale use of coal with minimal GHG implications.

- Give preference to import of natural gas, Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG) over import of coal and oil except for meeting specific fuel requirements (i.e. liquid fuel for transportation; coke for steel industry).

- Develop mass transit systems in large cities; further promote use of CNG as fuel for urban transportation.

6.1.1.2. Ongoing and Planned Actions

The government policy for mitigation effort in the energy sector, as embedded in MTDF 2005-10 (GoP-PC 2005) and Vision 2030 (GoP-PC 2007), envisages special emphasis on environmental considerations to control emission of GHG and particulates, and sets for itself the goal of reducing GHG emissions for getting access to carbon financing and bringing significant additional resources to the environment sector. Its particular focus is on: more efficient use of energy (see Table H-4 in Annex-H for Pakistan's comparison with other countries w.r.t. energy efficiency of the economy); energy conservation; increasing energy generation through renewable forms of energy; reducing dependence on imported energy through the development of hydropower resources, greater use of nuclear power using advanced nuclear power plants, and development and use of indigenous coal resources using clean coal technologies, including CO_2 capture and storage; and import of natural gas from neighbouring countries through pipelines to meet the bulk of energy demand still left unattended by domestic resources. Some other areas of emphasis are: conversion of existing thermal power stations from fuel oil to natural gas; efficient power generation through combined cycle power plants and integrated coal gasification combined cycle plants; reducing vehicle emissions through accelerating the use of mass transit

systems in major cities as well as hybrid vehicles; and making buildings more energy efficient, specially for reduction of air-conditioning loads in summer.

The main features of energy mix relevant to mitigation effort as embedded in the Energy Security Action Plan for the period 2005 to 2030 (GoP-PC 2005, 2007) (see Tables H-1 and H-2 in Annex-H) are:

(i) Primary Commercial Energy

- Total energy will increase 6.5 fold from 55.5 mtoe in 2005 to 361 mtoe in 2030, with energy import dependence increasing from 29% to 43%.
- Renewable energy will increase from practically zero to about 9 mtoe in 2030, commanding a 2.5% share in total energy in 2030.
- Hydroelectric energy will increase more than 6 fold but its share will remain unchanged as 11%.
- Nuclear energy will increase 22 fold, with its share increasing from 1% to 4%.
- Natural gas use will increase almost 6 fold but its share will decrease from 51% to 45%; nearly 90% of the gas supplies in 2030 will be based on imports.
- Oil use will increase 4 fold, with its share decreasing from 29% to 19%.
- Coal use will increase 16 fold, while its share will increase from 8% to 19% (The government hopes that a large fraction of future coal use will be subject to CCS technology application.)

(ii) Power Generation Capacity

- Total power generation capacity will increase more than 8 fold from about 19,500 MW to 162,500 MW.
- Renewable energy based capacity will increase 54 fold from 180 MW to 9,700 MW, with its share in total capacity increasing from 1% to 6%.
- Hydro capacity will increase 5 fold, while its share will drop from 33% to 20%.
- Nuclear capacity will increase 22 fold, with its share increasing from 2% to 5%.
- Natural gas capacity will increase 14 fold, with its share rising from 30% to 52%.
- Oil fired capacity will increase by only 20%, while its share will fall from 33% to 5 %.
- Coal fired capacity will increase 125 fold with its share jumping from 1% to 12%. (It is hoped that most of this capacity would be ale to benefit from CCS technology.

It is estimated that, as per evolution of energy supply system envisaged in ESAP 2005-30, the ratio of CO_2 emissions from fossil fuel consumption to primary commercial energy use in 2030 will be essentially the same as in 2005 (2.55 t CO_2 /toe) in case no CCS technology is used but will decrease by 13% if, say, two-thirds of all coal used in 2030 were covered by CCS technology at 90% efficiency for capture and sequestration.

A number of steps in line with the ESAP 2005-30 have been taken over the last few years which represent concrete actions by Pakistan towards mitigation. Salient among them are:

- A number of oil fired plants have been converted to gas firing; more conversions are in progress;

- Approval was given in August 2009 for construction of 4,500 MW Bhasha dam project; construction wok is scheduled to start later this year with completion expected in the next 8-10 years;

- Some 300 micro and mini hydroelectric plants, installed by the private and public sector in the northern hilly areas, are already supplying electricity to areas not connected with the grid. Construction of several more such projects was approved in August and September 2009;

- Approval was given in May 2004 for construction of the third 300 MW unit of Chashma Nuclear Power Plant; construction work started in 2005 and is expected to be completed by 2011;

- Agreement was finalized with Iran in May 2009 for construction of a 42 inch diameter gas pipeline from Iran to Pakistan with capacity to transport 750 Milliom cft of gas per day; the work on the project is envisaged to start in mid-2010 and to be completed by 2013; negotiations are in progress for import of gas from Turkmenistan and Qatar as well.

- Windpower capacity of 6 MW has already been connected to the grid, while 18 windpower projects of 50 MW, each, are underway. Electricity generation capacity based on renewable forms of energy (wind, solar, small hydro etc.) is envisaged to be increased from 180 MW in 2005 to 880 MW in 2010 and 9,700 in 2030 (GoP-PC 2005, 2007).

- A number of energy conservation and energy efficiency improvement projects, including energy efficiency in buildings and industry, being pursued and promoted by the ENERCON;

- Development and dissemination of several renewable energy technologies e.g. biogas plants, solar water heaters, solar cookers, efficient woodfuel stoves, photovoltaic systems for rural households and remote areas, small windmills for pumping drinking water etc., is being pursued by Alternative Energy Board and Pakistan Council for Renewable Energy Technologies. It is envisaged that under the remote village electrification programme, the first 400 villages (54,000 homes) will be electrified by AEDB through wind and solar sources by 2010.

- The main utilities WAPDA and Karachi Electric Supply Corporation (KESC) are working on reduction of T&D losses in the national electricity grid to meet the targets set in MTDF 2005-10 viz. reduction of losses from 26.5% in 2005 to 21.5% by 2010.

- The MTDF envisages exploring the possibility for linking and developing the regional power grid for efficient and reliable use of power with emphasis on import of power from Tajikistan and Kyrgyzstan on 765 kv transmission line through silk route;

- Major emphasis has been placed in MTDF and Vision 2030 on exploiting coal resources for large-scale use in power generation, and possibly for the production of coal bed methane. Furthermore, it has been planned to promote CCS technology aggressively; the target set for 2030 is to attain 90 percent carbon dioxide capture, and 95 percent storage permanence at less than 10 percent increase in the cost of energy services.

- Approval was accorded in August 2009 for constructing initially a 50 MW coal fired plant based on Thar coal, to be followed by additional 1,000 MW capacity within the next 5 years. IGCC approach will be investigated for large scale power generation based on Thar coal. It is envisaged to make use of CCS technology to minimize CO_2 emissions from large coal fired power plants.

- The government's Vision 2030 also envisages that big emitters such as cement, oil refining, power, pulp and paper, and steel industries be asked to restrict their greenhouse gas emissions by managing the corresponding cost implications through international carbon trading;

- Approval was given in September 2009 for construction of a mass transit system (circular railway) for Karachi metropolitan area. The construction work is expected to start later this year and to be completed within 3 years.

- An active programme is underway since 1990s to convert small urban transport vehicles (cars, vans etc.) to run on CNG as an alternate fuel to gasoline. Some 380,000 vehicles were already using CNG in 2005; MTDF envisages to increase this number to 800,000 by 2010 and to 920,000 by 2015 as Millennium Development Goal. The tally of vehicles converted to CNG as of April 2009 was over 2.0 Million (GoP-MoF 2009).

- It is envisaged to gradually replace gasoline engine vehicles with hybrid vehicles, which can run on at least two fuels (from gasoline, CNG and bio-fuels), and electric storage. Pakistan has started work on both the bio-fuel routes: the sugar-ethanol route and the cellulose biomass–bacteria route. However, in view of potential risks of competing with land meant for food, Pakistan will need to watch the potential negative impact of biofuels production very carefully.

6.1.2. Agriculture and Livestock

As discussed in Section 3, total GHG emissions from Agriculture and Livestock sector in 2008 were 120 million tonnes of CO_2 equivalent. These arose mainly from four sub-sectors: (1) Enteric fermentation in cattle: 80 mt CO_2 equiv. (all as Methane) (2) Rice

(paddy) cultivation: 8 mt CO_2 equiv. (all as Methane), (3) Manure management: 7 mt CO_2 equiv. (95% as Methane, 5% as Nitrous oxide), and (4) Agricultural soils: 25 mt CO_2 equiv. (all as Nitrous oxide due to crop fertilization by inorganic fertilizers) (PAEC-ASAD, 2009). During 1994-2008, the overall GHG emissions from the Agriculture and Livestock sector grew at about 3% per annum.

Not much attention has so far been paid in Pakistan to address the GHG emissions from the Agriculture and Livestock sector. However, in view of the fact that the sector is responsible for almost 40% of Pakistan's total GHG emissions, there is a pressing need to find ways and means to contain these emissions or at least slow down their rate of growth.

Some possible approaches that need to be properly explored are:

- Use vast mass of cultivable wasteland as Carbon sink to build up organic soil matter and mitigate on pollution in rural Pakistan.

- Develop and adopt new breeds of cattle which are more productive in terms of milk and meat but have lower methane production from enteric fermentation;

- Develop and promote new economical feeds that, on the one hand, provide better nutrition to the cattle and, on the other hand, reduce their methane production activity. Such feeds may be used as supplement to the usual fodder and customary feeds.

- Develop and adopt new methods of rice cultivation that are less demanding of water and also result in lower emissions of methane.

- Explore methods for reducing Nitrous oxide releases from agricultural soils, e.g. by changing the mix of chemical fertilizers commonly used.

- Make use of agricultural and animal wastes to produce biogas and organic fertiliser, thereby providing cost effective disposal of such wastes in an environmentally friendly manner.

The initiatives being taken by the government to develop new crop and cattle breeds to reduce their vulnerability to climate change (see Section 6.2.2.2) could possibly be adapted to address also the GHG mitigation issue in the Agriculture and Livestock sector.

6.1.3. Forestry

Forests act as a sink of carbon dioxide, the major greenhouse gas responsible for global warming. They sequester carbon, i.e. absorb and convert atmospheric carbon dioxide into tree biomass via the process of photosynthesis in the young growing trees. During the process, oxygen is released which makes the environment refreshingly healthy. Forest reserves also exert a cooling effect on the climate besides being a source of livelihood for the dependant communities. Afforestation and reforestation activities could be a good

choice for mitigating climate change as young forests can store as much as 15 tonnes of carbon per hectare per year in their biomass and wood.

As discussed in Section 5.5, Pakistan has only 4.8% of its total land area under forest cover; even this limited area is threatened by indiscriminate cutting of trees for fuelwood and timber; and, despite realisation of the pressing need for increasing forest cover to improve the country's overall environment, prevent degradation of land in mountainous areas and reduce silting of dams, little progress could be made in this direction over the last 35 years (GoP-PC 2005). Pakistan should now intensify its afforestation and reforestation activities in order to meet its long standing objectives of overall environmental improvement, preservation of ecology in the mountainous areas and control of silt accumulation in the major dams.

At the same time, effort should be made to minimise illegal cutting of forest trees for fuelwood and timber by providing cheap alternatives to use of wood as fuel and timber, and making efficient cooking stoves available cheaply and easily to the rural communities. Also multipurpose fast growing indigenous and exotic tree species may be planted on farmlands in order to meet the needs of timber, fuelwood and fodder for livestock.

The government of Pakistan is live to the above issues and has been taking various steps to check deforestation and aggressively pursue afforestation and reforestation programmes (GoP-PC 2005):

- The current government plans envisage increasing forest cover (including state and private forests / farmlands) from 4.9% of the total land area in 2005 to 5.2% in 2010 and 6.0% by 2015 as the Millennium Development Goal.

- In order to enhance tree cover in the country, the government is undertaking various projects like Rachna Doab Afforestation Project, Watershed Management in Tarbela Reservoir Catchments, and Mangla Watershed Management Project.

- The above is being complemented by tree-planting campaigns each year during spring and monsoon seasons. Afforestation rates increased from 70 thousand saplings per annum in the 1970s to 250 thousand per annum in recent years. As many as 541,176 saplings were planted in one day on 15 July 2009, which is a world record for any country.

- Projects and programmes are also being developed for protection of existing forests and restoration of depleted state, community, and private owned forests.

- Proposed and under-development afforestation and reforestation programmes are being encouraged to take advantage of Carbon financing available through CDM.

- LPG use is being promoted in Northern/ Hilly areas for reduction of fuel wood consumption.

6.2. Adaptation

There are two types of adaptations which help to cope with the negative impacts of climate change: autonomous and planned. Autonomous adaptations generally refer to those adjustments that are carried out irrespective of the knowledge of climate change, while planned adaptations are those made deliberately in order to address the expected climate change impacts. So far most of the adaptation effort undertaken in Pakistan falls in the category of autonomous adaptations. The following sections describe the adaptation needs of various sectors in Pakistan and identify the corresponding ongoing national actions and plans.

6.2.1. Water Resources

As discussed in Section 5.1, the fresh water resources of Pakistan are based on snow- and glacier-melt and monsoon, both being highly sensitive to climate change. The existing information strongly suggests the following future trends: decrease in glacier volume and snow cover leading to alterations in the seasonal flow pattern of IRS rivers, increased annual flows for a few decades to be followed by decline in flows in subsequent decades; increase in the formation and burst of glacial lakes; higher frequency and intensity of droughts and floods; and greater demand of water due to higher evapotranspiration rates at elevated temperatures. These trends will further exasperate the already difficult situation of a water stressed-country facing demand increases due to population growth and increasing economic activity.

6.2.1.1. Recommended Measures

Some key adaptation measures that will help in enhancing Water Security in the wake of climate change are identified below:

- Reduce losses in the system of irrigation water supply and use to the maximum possible extent by reducing seepages from the canals and distribution networks and by adopting modern, more efficient irrigation techniques (e.g. use of sprinklers and trickle irrigation) to replace the conventional method of flood irrigation.

- Build sufficiently large reservoir capacity on Indus and its tributaries so as to ensure no flow of Indus water down Kotri, even during high flood years, in excess of that necessary for environmental reasons including prevention of excessive influx of sea water into the Indus deltaic region.

- Once a sufficiently large reservoir capacity is in place, use some of it as carry over dams instead of the current practice of seasonal storage only so as to be able to use excess water saved during a high flood year in the subsequent lean years.

- Ensure that, while making water allocations (within gross national availability) to various sectors in the medium- to long-term future, due consideration is given to changes in sectoral demands caused by climate change.

- Address sea water intrusion into Indus deltaic region by allocating enough water to ensure minimum environmental river flows down Kotri.

- Legislate and enforce industrial and domestic waste management practices to protect environment, in particular water resources, from further degradation.

- Protect and enhance resilience of water-bodies, lakes, flood plains, etc.

- Protect groundwater through management and technical measures like regulatory framework, artificial recharge.

- Introduce local rain harvesting measures;

- Sensitize existing schemes like flood and drainage plans to climate change impacts.

- Introduce stringent demand management and efficiency improvement measures in all water use sectors, particularly in the supply, distribution and use of irrigation water.

- Improve efficiency of around one million ground water pumping units which are currently operating at typical efficiency of 20-25%.

- Ensure measurement and monitoring of water delivery at various points of supply system for effective planning and management. This will also provide base for volumetric water pricing in future which is essential for conservation and high value use of scarce water resources.

- Formulate National Water Law for improved governance and accountability.

- Manage wastewater through proper treatment and reuse it in agriculture, artificial wetlands and groundwater recharge. In particular, improve water efficiency by managing and reusing marginal quality irrigation effluent.

- Enhance national monitoring capacities for monitoring (i) gross river flows, (ii) temporal changes in the volumes of major glaciers and snow cover, and (iii) meteorological parameters, by increasing the number of monitoring stations in accordance with international norms, particularly in the northern areas of the country, and by upgrading their data gathering, and data transmission and processing capabilities. Full use should be made of state-of-the-art analytical tools such as Remote Sensing (RS) and Geographical Information System (GIS) techniques to obtain information which can not be gathered through conventional techniques.

- Also enhance national capacity for making quantitative assessments of climate induced changes and for analysing and implementing appropriate technical and management solutions. Again, full use should be made of state-of-the-art analytical tools such as Regional Climate Models and Watershed Models.

- Develop National Water Resources Information System for fast data communication and analytical planning to meet challenges of droughts and floods.

- Enhance capacity to address the impacts of floods, flash floods, droughts etc. by strengthening National Disaster Management Authority and related provincial and district level organizations.

- Improve inter-agency as well as international coordination for information collection and sharing.

- Develop a National Water Policy which, inter alia, duly addresses the water related vulnerabilities induced by climate change.

6.2.1.2. Ongoing and Planned Actions

The Government of Pakistan (GoP) is very concerned about the future Water Security of the country and has been taking various steps which implicitly represent Pakistan's actions and plans towards adaptation in the Water sector. Salient steps are outlined below:

Storage capacity

- In order to overcome the current shortages and meet the future needs of the reservoir capacity, Pakistan envisages increasing the storage capacity by 18 maf (6 maf for replacement of storage lost to silting /sedimentation, and 12 maf of new storage) by 2030. Water projects with power generation potential will be given preference over those without such a potential. The development will involve construction of a series of hydro power projects on all rivers, particularly Indus, and will include some large storages located at Bhasha-Diamer, Kalabagh, Kurram Tangi, Munda, and Akhori (GoP-PC 2005, 2007). Besides building major new water storage facilities, 'raising' of many of the existing ones is also envisaged (GoP-PC 2007). The Executive Committee of the National Economic Council (ECNEC) has recently (in August 2009) accorded its approval for the construction of the Bhasha-Diamer multi-purpose dam project with 6.4 maf water storage capacity and 4,500 MW hydropower capacity. The construction work is expected to start in October 2010 and would be completed in the next 8-10 years. It is expected that the Bhasha-Diamer dam will also be helpful in reducing the sedimentation of Tarbela dam.

- It is envisaged that the large storages will be complemented by a comprehensive programme of small dams as well as measures for recharging underground reservoirs in order to overcome the serious environmental consequences resulting from over-mining of the aquifer due to massive expansion of tube-well irrigation to the tune of 45 maf, which is twice the average annual rainfall (GoP-PC 2007).

- Recognising that small surface water carryover storages do not provide effective relief against drought because of high evaporation losses of surface water bodies, it has been decided to investigate the feasibility of using groundwater aquifers as water storage facilities (GoP-PC 2005).

- Taking note of the fact that on the average 35 maf of water flows to the sea annually during flood season while the country's current storage capacity at 9 per cent of average annual flows is very low compared with the world average of 40 per cent, the government is very keen to increase the storage capacity to conserve every drop not required for optimal ecological flow into the sea (GoP-PC 2007).

Water Use Efficiency

- In view of growing water scarcity, Pakistan has adopted the strategy "More Crop per Drop" in its Medium Term Development Framework 2005-10. This strategy calls for the use of improved irrigation methods and practices, developing crops with high yields and lower water consumption, and use of water saving techniques etc. It is envisaged that drought-tolerant and water-use efficient crop varieties will be developed through the use of biotechnology techniques.

- It is planned to offer incentives for adoption of water saving technologies such as laser land leveling, furrow irrigation and high efficiency irrigation systems (e.g. drip, sprinkler and trickle irrigation), instead of extravagant gravitational irrigation (GoP-PC 2005 2007).

- A major programme is already underway for lining the water channels. This will certainly improve water at the farm gate but, it is feared, it would have a negative impact on recharge of underground aquifers (GoP-PC 2007).

Glaciers

- In view of the expected serious consequences of de-glaciation of northern Pakistan for water availability in Indus basin, Pakistan has planned to 'monitor continuously the movement of glaciers in northern Pakistan' as a part of its Programme and Action Plan for 2005-10 (GoP-PC 2005).

Capacity Building

- The government has committed itself to encourage and support Meteorological and other Departments / Agencies in carrying out research work aimed at developing appropriate mathematical models for reliably predicting droughts (in terms of several months or even a year ahead) so that feasible countermeasures may be timely taken through modified releases from reservoirs and other appropriate water management strategies may be worked out. (GoP-PC 2005). The MTDF also recommends development of mathematical modeling capacity for climate change impacts on watersheds and water management.

National Water Policy

- A draft national water policy has been prepared by the Pakistan Engineering Council with inputs from highly professional experts in water resources from all over the country; it is presently under legislation process.

6.2.2. Agriculture and Livestock

As discussed in Section 5.2, agriculture and food security in Pakistan would be particularly threatened due to increased heat and water stress on crops and livestock and increased intensity and frequency of floods and droughts resulting from changes in climate. As not much scope is left for expansion of cultivated land area (it increased by only 5% over the last 30 years) or the irrigation water supplies (unless the reservoir capacity is substantially increased) while the demand for food and fibre is increasing under the pressure of a growing population, Pakistan has no option but to take major steps for increasing its land productivity and water-use efficiency, which at present are considerably lower than those in many other countries. The World Bank (2006) in its report on Pakistan's Water Economy points out that the wheat yield per hectare in Punjab, Pakistan is only about 2 tons as compared to 3.5 tons in Bhakra, India and 7 tons in Imperial Valley, USA (see also Table 6.1 for a comparison of wheat and rice yields per hectare in 2005 in various countries), while the wheat yield per cubic meter of water for the same three locations in Pakistan, India and USA is about 0.45 Kg, 0.8 Kg and 1.1 Kg respectively. These figures point to what may be realistically achievable through appropriate measures including those designed to address specific climate change concerns.

Table 6.1: Average Yields (Kg / hectare) of Selected Crops, 2005

Country	Wheat	Rice (Paddy)
World	2,906	4,019
Egypt	6,006	9,538
China	4,227	6,266
India	2,717	3,007
Pakistan	2,586	1,995

Source: (GoP-PC 2007)

6.2.2.1. Recommended Measures

Since the agriculture sector is heavily dependent on the water sector, a number of adaptation measures identified in Section 6.2.1.1 (e.g. those for increasing water storage

capacity or for improving water use efficiency) are equally applicable here and will generally not be repeated. Some additional adaptation measures that will help in enhancing the Food Security of Pakistan are outlined below:

- Establish Climate Change Cells in MinFA and PARC to devise adaptative strategies for projected impacts of climate change on agriculture;

- Develop computerised simulation models for assessment of climate change impacts on physical, chemical, biological and financial aspects of agricultural production systems in all agro-ecological zones;

- Improve the crop productivity per unit of land and per unit of water by increasing the efficiency of various agricultural inputs, in particular the input of irrigation water;

- Promote energy efficient farm mechanisation for increasing yield, water conservation and labour saving;

- Improve farm practices by adopting modern techniques such as laser land levelling, crop diversification, proper cropping patterns, optimised planting dates etc.;

- Provide incentives for adoption of water saving technologies such as laser land leveling, furrow irrigation and high efficiency irrigation systems (drip & sprinkler), instead of extravagant flood irrigation;

- Develop new breeds of various crops which are high yielding, resistant to heat stress, drought tolerant, less vulnerable to heavy spells of rain, and less prone to insect pests;

- Develop and introduce better varieties of livestock which have higher productivity of milk and are less prone to heat stress and more drought tolerant;

- Promote horizontal expansion of cultivated lands through development of wastelands (potentially 8.25 Mha) and rainwater harvesting through community based approaches to development;

- Improve the quality of rangelands by increasing native rangeland vegetation and planting adapted species, and by proper rangeland management;

- Use feed conservation techniques and fodder banks in the arable areas; provide some good quality feed and fodder to livestock to supplement their grazing in the rangelands; improve nutritional quality of feed through the use of multi-nutrient blocks (MNB) prepared from urea, molasses, vitamins and minerals;

- Develop quality datasets on crop-, soil- and climate-related parameters to facilitate research work on climate change impact assessment and productivity projection studies;

- Expand and upgrade meteorological services for weather and climate information and make full use of World Meteorological Organization's (WMO) new initiative to create Global Framework for Climate Services (GFCS);

- Enhance the research capacity of various relevant organisations to make reliable predictions of climatic parameters and river flows at seasonal, inter-annual and inter-decadal levels, to assess the corresponding likely impacts on various crops and to develop appropriate adaptation measures;

- Enhance the capacity of the farming community to take advantage of scientific findings of the relevant research organisations;

- Improve the extension system to allow effective and timely communication of climatic predictions and corresponding advice from research organisations to the farming community;

- Develop capacity based on Remote Sensing and GIS techniques to assess temporal changes in land cover in different agro-ecological zones, and in the extent and intensity of degradation in cultivated areas affected by waterlogging, salinity, and wind and water erosion, particularly in the fragile ecological zones (mountains, coastal areas, hyper-arid areas etc.);

- Develop a proper risk management system to safeguard against crop failures and extreme events (floods, droughts etc.); and

- Formulate an agriculture policy for the country in the context of climate change to facilitate development and implementation of various adaptation measures to counter the adverse impacts of climate change.

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6.2.2.2. Ongoing and Planned Actions

The government's main objectives in the field of agricultural development are to achieve self-reliance in agricultural commodities, ensure food security and improve productivity of crops (GoP-PC 2005, 2007). The steps taken or planned by the government to achieve these objectives implicitly represent Pakistan's plans and actions on adaptation in the agriculture sector. Because of intimate relationship between water and agriculture sectors, several of the adaptation steps are common to both the sectors and have already been described in Section 6.2.1.2; generally those will not be repeated here. With this proviso, salient adaptation steps in the agriculture sector are described below.

Crop Productivity

In view of the need to increase the production of major agricultural products with lesser land and water resources than are available for agriculture today, it is planned to enhance crop productivity through development of high yielding varieties, use of improved and hybrid seed, balanced use of fertilizers and micro-nutrients, integrated pest management, and judicious application of other plant protection measures (GoP-PC 2005, 2007).

New Breeds of Crops
It is planned to develop through biotechnology, drought-tolerant, salt tolerant and water-use efficient crop varieties with high yields and lower water consumption. It is also envisaged to develop crop varieties which are more drought as well as more flood tolerant (GoP-PC 2005, 2007).

Efficiency of Water Use
Pakistan's strategy for Medium Term Development Framework 2005-10 (GoP-PC 2005) is "More Crop per Drop" through improved irrigation methods and practices, and developing crops with high yields, lower water consumption and water saving techniques etc. In line with this strategy the government is promoting efficient use of water through lining of water courses, precision land leveling and high efficiency irrigation systems (e.g. drip, sprinkler and trickle irrigation). It also plans to offer appropriate incentives to users of such technologies (GoP-PC 2005, 2007).

Efficiency of Other Agricultural Inputs
The government's MTDF 2005-10 (GoP-PC 2005) envisages deliberate effort on the part of various stakeholders to work towards improving efficiency of all agricultural inputs other than water as well (e.g. fertilizer, pesticides and herbicides, field operations for land preparation and harvesting etc.) and ensuring their timely availability to farmers.

Water Intensive Crops
Rice is an important source of export earnings for Pakistan. The current level of annual production is about 5.5 million tons of which more or less half is exported. The government's Vision 2030 document (GoP-PC 2007) notes that every million ton of rice export implies a virtual export of nearly half a million acre -feet of precious water. The pros and cons of rice export are under consideration of the government in view of the growing scarcity of water in future.

Water Storage Capacity
The government is keenly interested in creating additional water storage capacity (see also Section 6.2.1.2) in order to overcome increasing water scarcity, bring additional area under cultivation, and increase cropping intensity and productivity (GoP-PC 2005, 2007).

Post-Harvest Losses
It is estimated that as much as10-15% of the crop production in Pakistan is lost due to improper handling of the produce, insect pests, inadequacy of proper storage facilities delays in transportation of the produce to the markets or storage facilities etc. The MTDF 2005-10 envisages effort to reduce the post-harvest losses and promote value addition of agricultural products.

Degraded Croplands and Rangeland
Degradation of land resources due to water logging and salinity is considered as a major challenge by Pakistan. It is planned to reclaim large tracks of salt affected waste land as well as large areas of sandy desert through an integrated approach, whereby salt tolerant, fast growing grasses, shrubs & trees could be grown on such land and used as animal fodder or for economic conversion to methane or ethanol (GoP-PC 2005, 2007).

Livestock

Taking note of the fact that due to inadequate and poor quality of feed, poor health coverage, indiscriminate breeding of genetically inferior livestock, the average milk yield per cattle (cow / buffalo) is only a fraction of the world average, major initiatives have been launched to improve animal breeds and feedstock. Furthermore, it is planned to develop animal types, which are less vulnerable to climatic changes (GoP-PC 2007).

Capacity Building

It is planned to strengthen agricultural research institutions in the country and improve their capacity for research and extension and improving their linkages and coordination (GoP-PC 2005). The MTDF 2005-10 also recommends development of mathematical modeling capacity for climate change impacts on crop production, watersheds, water management etc.

6.2.3. Coastal Areas and Indus Deltaic Region

The main concerns regarding the vulnerability of coastal areas of Pakistan to climate change were outlined in Section 5.4. In brief, these relate to the impacts of sea level rise resulting in erosion of beaches, flooding and inundation of wetlands and lowlands, salinization of ground and surface waters, and increased intrusion of sea water into the Indus deltaic region as well as the increased risk of cyclones originating in the Arabian Sea.

6.2.3.1. Recommended Measures

The following are the key adaptation measures identified to address these concerns:

- Collect data on the sediment and water discharges from the Indus river into the Arabian Sea as well as on the ground subsidence in the deltaic and coastal areas along the southern Sindh so as to allow reliable assessment of the extent of sea water intrusion in the region;

- Implement appropriate protective measures (such as construction of structures like dikes and seawalls) at strategic points on the coast; a coastal wall provided at Clifton beach may be extended to cover a much larger part of the beach in the vicinity of Karachi;

- Protect mangrove forests as, besides being a rich source of nutrients for a variety of marine species and breeding grounds for many varieties of coastal fish, they provide a natural defence system along the coast;

- Regulate ground water extraction in the deltaic and coastal areas in order to reduce ground subsidence rate;

- Address sea water intrusion into Indus deltaic region by allocating enough water to ensure minimum environmental river flows down Kotri;

- Develop capacity to deal with natural disasters and extreme weather events like cyclones, floods and droughts covering both disaster preparedness and disaster management aspects (the disaster preparedness aspect should include establishment of efficient data collection and monitoring systems, communication systems and early warning systems); and

- In the long run, if necessary, relocate communities and infrastructure currently located in highly threatened zones.

6.2.3.2. Ongoing and Planned Actions

In order to address the issue of minimum required water escapages below Kotri Barrage to check seawater intrusion and address other environmental concern, the government of Pakistan in 2005 commissioned a group of studies and got their findings reviewed by an International Panel of Experts (IPOE). The IPOE (2005) has recommended, inter alia: (i) an escapage at Kotri Barrage of 5,000 cfs or 0.3 maf per month throughout the year is required to check seawater intrusion, accommodate the needs for fisheries and environmental sustainability, and to maintain the river channel, and (ii) in order to supply sediment to the delta, sustain mangrove vegetation and preserve river morphology, an additional total volume of 25 maf in any 5 years period (an annual equivalent amount of 5 maf) needs to be released in a concentrated way as flood flow (in Kharif period i.e. during April- September), to be adjusted according to the ruling storage in the reservoirs and the volume discharged in the four previous years. IPOE notes that this will require additional storage capacity to prevent a reduction of water availability for irrigated agriculture. However, the recommendations still remain to be implemented, on the one hand, due to insufficient storage capacity and, on the other hand, pending a consensus agreement among the four provinces.

- It is envisaged under the Programme and Action Plan of MTDF 2005-10 to restore the degraded mangroves & marine system.

- The fisheries sector has remained neglected in the past. In view of the vast potential of the Indus delta and the nearby Arabian Sea for both coastal and inland aquaculture, major interventions are now planned by the government to boost fisheries through provision of technical and financial assistance to the fishing communities. A major intervention underway is to use brackish water for aquaculture, which will not only alleviate the poverty in coastal communities but also improve food security and the environment (GoP-PC 2007).

- A National Disaster Management Authority was established by the government in 2006. The organization is responsible for both disaster preparedness and disaster management in respect of all major disasters including earthquakes, floods, droughts, cyclones etc.

6.2.4. Forests and Other Vulnerable Ecosystems

The likely impacts of climate change on forests and other vulnerable ecosystems (including mangroves, rangeland, degraded lands, mountainous regions and biodiversity) in Pakistan were discussed in Section 5.5. In general, the main concerns are decreased productivity, changes in species composition, increase in forest insects, pests and weeds, and reduction of forest area; increased degradation of mangroves resulting from increased intrusion of sea water into the Indus delta due to sea level rise; greater risks of GLOF and landslides in mountainous regions; further degradation of rangelands and degraded areas affected by waterlogging, salinity etc., due to utter lack of adaptation capacity in these impoverished regions.

6.2.4.1. Recommended Actions

Some appropriate adaptation actions are identified below:

- Discourage deforestation to safeguard environment and protect carbon sinks, by providing alternate means of fuel and livelihood to the nearby population.

- Aggressively pursue reforestation and afforestation programmes with plantation suited to the looming climate change. This will be helpful not only in increasing the forest covered area in the country but also in earning Carbon Credits under the CDM of Kyoto Protocol.

- Ensure biological control of forest pests by maintaining viable populations of predatory birds and insects through restricted use of chemical insecticides and encouragement of both natural and artificial conditions conducive for their fast breeding and multiplication.

- Plant multipurpose fast growing indigenous and exotic tree species on farmlands in order to meet the needs of timber, fuelwood and fodder for livestock.

- Promote the use of energy efficient cookers especially in mountain areas where the fuelwood demand is already very high.

- Restore the degraded mangroves in the deltaic region by allowing minimum necessary environmental flows down Kotri.

- Revive rangelands and create artificial wetland where ever secondary water resources are available or rain harvesting is possible.

- Using appropriate varieties of grass, increase grass lands in saline and waterlogged zones to prevent their degradation, provide fodder to livestock and to contribute towards biological carbon sequestration.

- Assist genetically impoverished species or those that have important ecosystem functions by providing natural migration corridors as well as assisted migration in order to keep up with the speed with which their habitats shift with climate change and change in land use.

- Make use of gene banks, seed banks, zoos and botanical gardens for preserving genetic diversity and conserving species out of their natural environment.

6.2.4.2. Ongoing and Planned Actions

Some of the main policies and actions of the government of Pakistan which implicitly address the adverse impacts of climate change on forests and other vulnerable ecosystems are:

- The forest cover (including State and private forests/farmlands) is planned to be increased from 4.9% in 2004-05 to 5.2% of the total land by 2009-10 and, as the Millennium Development Goal, to increase it to 6.0% by 2015 (GoP-PC 2005).

- In order to enhance tree cover in the country, the government is undertaking various projects like Rachna Doab Afforestation Project, Watershed Management in Tarbela Reservoir Catchments, and Mangla Watershed Management Project.

- The above effort is being complemented by tree-planting campaigns each year during spring and monsoon seasons. Afforestation rates have increased from 70 thousand saplings per annum in the 1970s to 200,000-250,000 in recent years. As many as 541,176 saplings were planted on a single day on July 15, 2009, which is a world record.

- The government is planning to undertake additional major programmes for increasing the forested areas (GoP-PC 2007). In this connection it has been envisaged: to carry out intensive institutional and legal reforms in forestry both at the federal and provincial levels; to revise and prescribe forest work plan on the basis of integrated ecosystem management approach; to prepare projects and programmes for protection of existing forests and restoration of depleted state, community, and private owned forests; to promote social forestry and integrated watershed management; and to intensify effort on large-scale afforestation on state, community and private lands to increase forest cover (GoP-PC 2005).

- The area protected for conservation of wildlife is planned to be increased from 11.3% of the total land in 2004-05 to 11.6% by 2009-10 and to 12.0% by 2015 (GoP-PC 2005).

- In order to reduce felling of trees in forests for use as fuelwood and timber, it is envisaged to identify environmentally sound, socially acceptable and cheap alternatives to substitute for wood as fuel and timber; in particular, it is planned to

promote LPG use in Northern/ Hilly areas to cut down on fuel wood consumption (GoP-PC 2005).

- The MTDF seeks to restore the degraded mangroves & marine system as a part of its Programme and Action Plan for 2005-10.

- The main steps planned for improvement of rangelands are: enactment of legislation to provide legal instruments and support to range land management; extending ground cover for retaining maximum rainwater on the grazing lands to protect against wind and water erosion; improvement of rangeland conditions through scientific management and restoration of native grasses and other forage species; prescribing grazing regimes on the basis of local ecology and practices of managing rangelands; and persuading farmers to practice controlled and rotational grazing(GoP-PC 2005).

- It is planned to develop through biotechnology, drought-tolerant, salt tolerant and water-use efficient crop varieties with high yields and lower water consumption. This will help in reclamation of nearly 6 million hectare of salt affected waste land and large areas of sandy desert through an integrated approach, whereby salt tolerant, fast growing grasses, shrubs & trees could be used as animal fodder as well as economic conversion to Methane or ethanol. (GoP-PC 2005, 2007).

- In order to avoid desertification and reclaim degraded lands, the main measures planned are: launching of a national sustainable land management project to combat desertification; enforcement of soil conservation measures; promoting rainwater harvesting techniques; discouragement of ground water harvesting for irrigation in water stress areas; reclaiming waterlogged and saline lands with the involvement of local communities/private sector; and rehabilitation of degraded rangelands (GoP-PC 2005).

- In order to address the issues related to preservation of biodiversity, the government's Programme and Action Plan for 2005-10 envisages, inter alia the following measures: use of Pakistan's Biodiversity Action Plan as the umbrella document for planning and Management; development of National Biodiversity Policy for implementation at federal and provincial levels; capacity building in biodiversity related research; development and implementation of Protected Area System Plan; development of national database of threatened and endangered species; and encouraging captive breeding of endangered species to promote ex-situ conservation of biodiversity (GoP-PC 2005).

6.2.5. Health

There are hardly any specific adaptation measures that may be suggested at this stage to address climate change related health impacts discussed in Section 5.6. A general improvement of overall environmental conditions, easy availability of clean drinking water, better sanitary and sewerage facilities, more protected homes against severe weather conditions, and an improved healthcare system will automatically take care of most of the adverse health impacts resulting from climate change. One possibility for taking some advance preventive steps against widespread attack of malaria would be to monitor the development of swarms of mosquitoes over water bodies through remote sensing from satellites.

6.2.6. Extreme Events

As discussed in Section 5.7, one of the climate-related particular concerns for Pakistan is the increased risk of extreme events: floods, droughts and cyclones. Being a developing country, Pakistan lacks adequate monitoring systems and analytical capacity for predicting the likelihood of occurrence of extreme events. Besides, until 2005 Pakistan did not have any disaster risk handling system either. However, in the aftermath of the October 2005 earthquake, such a system was put in place in 2006 by establishing a National Disaster Management Commission (NDMC) under the chairmanship of the Prime Minister, and setting up under it a National Disaster Management Authority. The NDMA has been made responsible to cover both disaster preparedness and disaster management aspects in respect of all national disasters, including earthquakes and climate extremes. The NDMA has formulated and put into force a National Disaster Risk Management Framework (NDRMF) to guide the work of entire system in the area of disaster risk management. The provinces also setup disaster management organizations at the provincial and regional levels. It is hoped that with adequate strengthening, capacity building and provision of financial support, this arrangement will go a long way in reducing the risks of extreme events and in reducing the human sufferings and financial losses caused by them.

7. ORGANIZATIONAL STRUCTURE TO ADDRESS CLIMATE CHANGE

7.1. Key Elements

The need to address climate change on a priority basis is now realised at the highest echelon of the government in Pakistan as is obvious from the existence since 2005 of a high level committee, called the Prime Minister's Committee on Climate Change, chaired by the Prime Minister and with several ministers including the Minister for Environment and the Deputy Chairman of Planning Commission as its members. This is an overarching body which meets about once a year to monitor the climate change related developments taking place globally and within Pakistan and provide overall policy guidance. GCISC serves as secretariat to PMCCC. An important direction given by PMCCC in the wake of major climate change concerns is that, in the first instance, Pakistan should focus its attention on the Water security and Food Security issues.

Over the last few years Pakistan has taken a number of policy decisions and concrete actions which correspond to some of the measures identified in this report to address various mitigation and adaptation issues and, as such, may be considered as implicitly representing Pakistan's actions to address climate change (see Section 6). However, a formal comprehensive national policy together with a plan of action specifically addressing climate change issues remains to be designed. The most important organ of the government in this respect is the Ministry of Environment (MoEnv) which, in terms of Rule 3(3) of Rules of Business of 1973, has been allocated the responsibility, inter alia, to develop national policies, plans and programmes regarding environmental planning, pollution and ecology, and to conduct dealings and agreements with other countries and international organizations in the fields of environment. The MoEnv coordinates its climate change related activities with other Federal Ministries and various relevant organizations through its "Inter-ministerial Committee on Climate Change" established in 2008.

The next important role in relation to formulation and implementation of the climate change policy and plan of action is that of the Planning Commission (PC) which, as per Schedule II of the Rules of Business 1973, is responsible for, inter alia, ppreparing the National Plans covering all socio-economic sectors and monitoring and evaluating the implementation of major development projects and programmes. In October 2008, the Planning Commission established a Task Force on Climate Change under the chairmanship of Advisor (Science & Technology), Planning Commission and assigned it with the responsibility to facilitate the formulation of a climate change policy by identifying and recommending appropriate policy measures for ensuring water security, food security and energy security of the country; for promoting large scale Adaptation and Mitigation efforts, including various CDM activities; for enhancing institutional capacities of various organizations, wherever lacking; and for enhancing understanding and awareness of climate change issues among all relevant stakeholders, including the general public. The full Terms of Reference are given in Annex-A. In addition to the chairman, the Task Force consists of 17 members (see Annex-B) comprising federal secretaries of key ministries (2: Environment; Industries), heads or senior representatives of some most relevant public sector organizations (7), heads of important international NGOs (4), and some reputable relevant scientists (4). In order to take full advantage of the technical expertise available in the country, the Task Force set up 9 Working Groups (Annex-C) comprising some 40 technical experts drawn from various relevant ministries, technical organizations and NGOs (see Annex-D). These working Groups are: WG on Climatology, WG on Glaciology, WG on Water, WG on Agriculture, WG on Energy, WG on Economics, WG on Communication and Awareness Raising, WG on CDM, International Cooperation and Financial Support, and WG on International Negotiations. Each WG is chaired by a member of the TFCC and comprises 5-10 relevant experts.

The above 4 set ups (PMCCC, MoEnv, PC and TFCC) currently represent the key elements of Pakistan's organizational structure for addressing climate change.

7.2. Other Main Elements

The other important elements with useful role in the planning of the national climate change policy and key role in its implementation (through mitigation, adaptation, awareness raising, capacity building, transfer of technology and funding support) are:

(i) **Relevant Federal Ministries**: Ministry of Food and Agriculture (MinFA), Ministry of Livestock and Dairy Development (MinLDD), Ministry of Water and Power (MoW&P), Ministry of Industries and Production (MoInd&P), Ministry of Science and Technology (MoST), Ministry of Foreign Affairs (MoFAff), Ministry of Health (MoH).

(ii) **Relevant Provincial Ministries and Departments** e.g. those dealing with agriculture, irrigation, forestry, environment etc.

(iii) **Research and Data Collection Organizations:** GCISC, PMD, Water & Power Development Authority (WAPDA), NIO, National Agricultural Research Centre /Pakistan Agricultural Research Council (NARC /PARC), Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan Institute of Development Economics (PIDE), Pakistan Atomic Energy Commission (PAEC), COMSATS Institute of Information Technology (CIIT), National University of Computer and Emerging Sciences (FAST), Hydrocarbon Development Institute of Pakistan (HDIP), Pakistan Forest Institute (PFI).

(iv) **Mitigation-related Organizations:** WAPDA, PAEC, NARC /PARC, PFI, HDIP, National Energy Conservation Centre (ENERCON), Alternative Energy Development Board (AEDB), Pakistan Council of Renewable Energy Technologies (PCRET), Pakistan Environment Protection Agency (Pak-EPA).

(v) **Adaptation-related Organizations:** NARC /PARC, WAPDA, PFI, Agricultural Universities (Agri-Univ), Provincial Irrigation Departments (PID), Pakistan Council for Research in Water Resources (PCRWR), National Disaster Management Authority (NDMA).

(vi) **Non Governmental Organizations (NGOs):** International Union for Conservation of Nature (IUCN), LEAD-Pakistan (LEAD), Sustainable Development Policy Institute (SDPI), International Centre for Integrated Mountain Development (ICIMOD), International Water Management Institute (IWMI), World Wildlife Fund (WWF), Oxfam International (Oxfam), Pakistan Institute for Environment-Development Action Research (PIEDAR), Asianics Agro Development International (Asianics).

(vii) **Inter-ministerial Committee on Climate Change:** The Committee is chaired by Secretary (MoEnv) and includes Secretary (MinFA), Secretary (MinLDD), Secretary (MoST), Secretary (Ministry of Housing and Works), Executive Director (GCISC) and Director General (PMD).

(viii) **Technical Advisory Panel (TAP):** The panel is led by IUCN and comprises climate change experts from GCISC, PMD, NARC /PARC and Asianics. It was set

up in 2008 with the approval of Ministry of Environment with a view to provide technical support to the Ministry on various climate change related issues, as and when needed.

(ix) **Academic Institutions:** Higher Education Commission (HEC), various Universities.

(x) **International Funding Agencies:** World Bank (WB), Asian Development Bank (ADB), UN Agencies (UNDP, GEF, UNIDO, UNESCO etc.), Donors (DFID, GTZ, NORAD, SDC etc.).

There are a few other aspects of the organizational structure in Pakistan for addressing climate change: (i) to conduct international negotiations within the framework of UNFCCC about the post-2012 climate change regime, (ii) to seek international support for various mitigation, adaptation and capacity building activities, and (iii) to plan, promote and oversee the implementation of CDM projects in different sectors. All of them are the prerogative as well as the responsibility of the Ministry of Environment. The first two of the above tasks are being managed by it in close cooperation with the Ministry of Foreign Affairs, with some technical support from TFCC, while the CDM related activities are exclusively being handled by MoEnv through one of its technical arms, called the CDM Cell.

Figure 7.1 presents a bird's eye view of the organizational structure in Pakistan for addressing climate change, showing linkages among various elements.

7.3. Recommended Measures

- The Prime Minister's Committee on Climate Change should be made the apex policy guidance and overview body on all climate change related issues.

- The Ministry of Environment may be renamed as the Ministry of Environment and Climate Change with a full-fledged Division of Climate Change headed by a Secretary or Additional Secretary and comprising departments dealing with mitigation, adaptation, research, technology, CDM, policy and external cooperation related subjects.

- All Federal Ministries whose core functions address sectors that are vulnerable to climate change should have Climate Change Focal Points whose strength and financial/human resources should correspond to the magnitude of the likely adverse impacts of climate change.

- While noting with satisfaction that the federal cabinet has recently approved the establishment of GCISC as an autonomous body under the Ministry of Environment, it is recommended that GCISC should be adequately staffed and financed to serve as an effective research arm of the ministry and undertake high quality climate change related research and modelling pertaining to cross-sectoral topics.

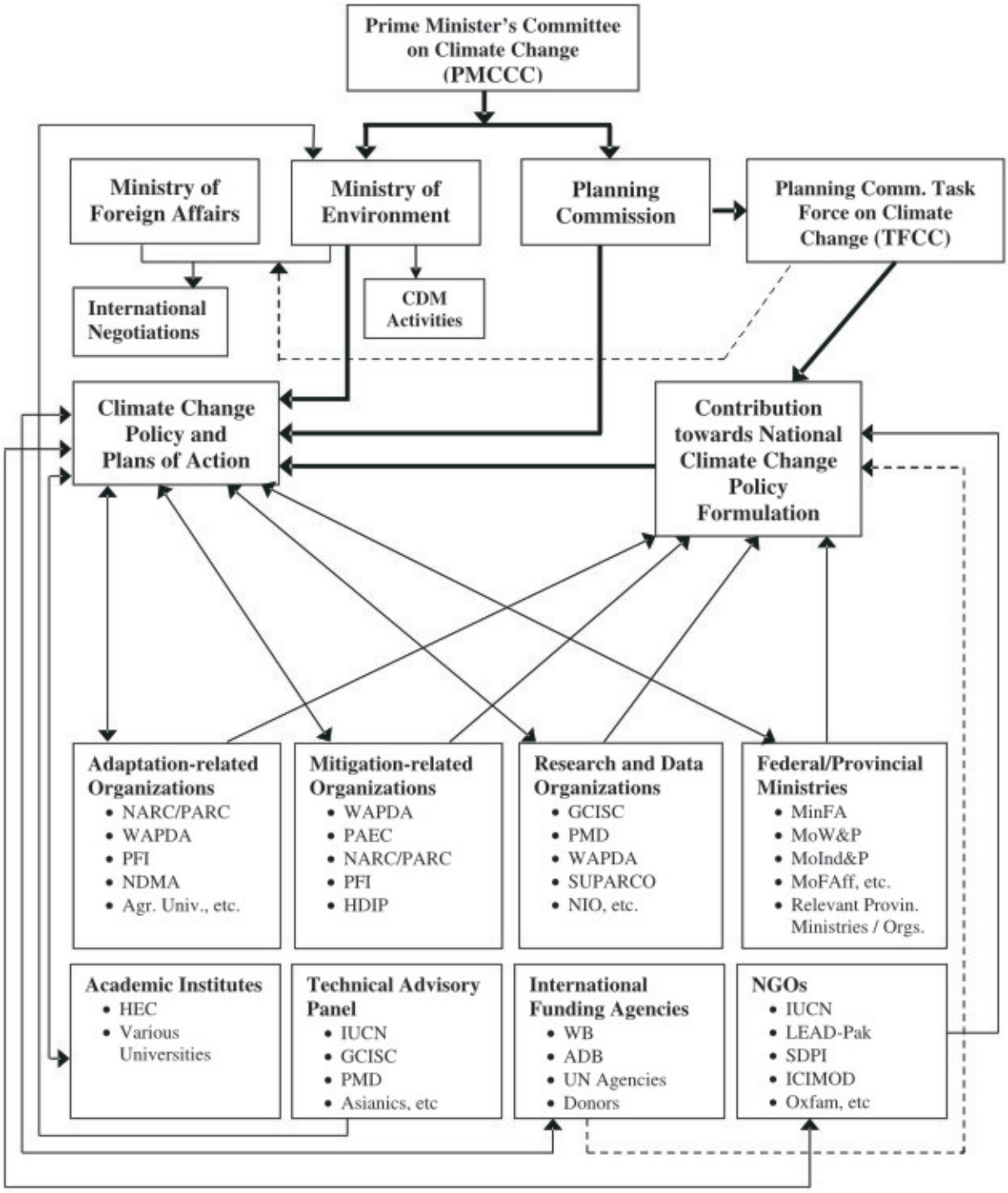

Figure 7.1: Pakistan's organizational structure for addressing Climate Change.

- All other R&D bodies which deal with various sectors e.g. NARC /PARC; NIO, PFI, PIDE etc., should continue to function as part of their parent ministries but with updated TORs in order to ensure that they contribute effectively towards fulfilment of the mitigation and / or adaptation targets for their respective sectors, as approved by the Government.

- Steps should be taken by the Ministry of Environment on priority basis to formulate a formal National Climate Change Policy along with a Plan of Action as a follow up of the TFCC Report.

- Successful implementation of the Climate Change Plan of Action will depend on the availability of robust institutions and adequate financial and human resources. For this necessary support and assistance should be sought from external sources such as UN and non-UN multilateral mechanisms (e.g. UNFCCC, the Adaptation Fund, GEF, UNEP, the World Bank, ADB), friendly governments, and scientific institutions / organisations in neighbouring countries, Europe, and North America.

- The existing Inter-ministerial Committee on Climate Change should be enlarged and made more functional.

8. CLEAN DEVELOPMENT MECHANISM (CDM) ACTIVITIES

8.1. Current Status

The Clean Development Mechanism is one of the Kyoto Protocol's three flexibility mechanisms (the other two being International Emissions Trading and Joint Implementation), and is aimed at helping industrialized countries meet their greenhouse gas reduction targets by investing in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries; it has been operational since the beginning of 2006. Although focused towards helping the industrialized countries, it is also meant to help developing countries achieve sustainable development by facilitating the transfer and/or development of low-emission advanced technologies. The CDM allows emission-reduction (or emission removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO_2. These CERs can be traded and sold, and used by industrialized countries to a meet a part of their emission reduction targets under the Kyoto Protocol. In case an industrialized country wishes to get credits from a CDM project it must obtain the consent of the developing country hosting the project that the project will contribute to its sustainable development.

Pakistan is participating in various mitigation activities, including CDM projects, on voluntarily basis because of their usefulness for its national sustainable development, clean environment, improved socio economic conditions, capacity building and transfer of technologies in line with the principle of 'common but differentiated responsibilities and respective capabilities', enshrined in the UNFCCC and the Kyoto Protocol. An added

advantage is that the CERs earned by Pakistan through the CDM activities, whether implemented at its own or in cooperation with industrialized countries, will generate funds – the so called Carbon Finance – that will boost the profitability and reduce the risk of clean technology investments by providing a high-quality, hard currency revenue streams from highly creditworthy sources that project sponsors can use to mobilize financing.

Pakistan ratified the Kyoto Protocol in January, 2005 and the Ministry of Environment has been declared as Designated National Authority (DNA) to process projects for CDM efficiently and transparently. A CDM Cell was also established as part of the DNA for approving and facilitating CDM projects in line with national sustainable development goals. The CDM Cell works with public and private sector partners in the CDM process for attracting investments in the potentially suitable projects, together with technology transfer and capacity building. A National Operational Strategy for CDM was approved by the Prime Minister of Pakistan in February 2006. Under this strategy the priority areas for CDM projects are: renewable/ alternate energy, energy efficiency/ conservation, fossil fuel co-generation, forestry (afforestation and reforestation), agricultural and livestock practices, waste management (landfills and composting), CNG and hybrid transport vehicles, mass transit systems, and industrial /chemical processes.

In its capacity as DNA, the Ministry of Environment has given Host Country Approval to 10 CDM projects which could bring an estimated foreign direct investment of US$ 322 million with GHG Reduction of 3.2 million tonnes per annum along with other national sustainable development, socio-economic and environmental benefits. More than 40 CDM projects are also in the pipeline. A number of national and international investors as well project development consultants are now getting interested in the CDM business in Pakistan.

8.2. Need for Further Effort

Despite the above effort, Pakistan has as yet not been able to take full advantage of the opportunities available through the CDM. Of the more than 2,000 projects registered by the mechanism as of January 2010, only 4 projects were from Pakistan which makes its share (0.2%) negligible compared to those of China (36%), India (24%), (Brazil (8%) and Mexico (6%). Furthermore, it is expected that the projects registered so far would result in average annual generation of about 340 million CERs of which Pakistan's share would be only 1.4 million or 0.4% as compared to 59% share for China, 12% for India, 6% for Brazil, 4% for Republic of Korea and 3% for Mexico (CDM 2010). With the expected extension of Kyoto Protocol together with additional emission reduction targets for Annex-1countries in the post-2012 climate change regime, it is very likely that the worldwide CDM activity will increase considerably and the monetary value of CERs may also go up. Pakistan therefore needs to intensify its efforts manifold to develop and submit high quality CDM projects in order to acquire a reasonable share in the global flows of CERs in relation to the shares of various countries mentioned above. For this, it seems necessary that the CDM Cell in the Ministry of Environment be appropriately strengthened with a view to perform the following activities:

i. Identify and assess CDM potential in all CDM eligible sectors in Pakistan and develop an inventory of appropriate environment friendly technologies;

ii. Promote CDM related research and development and conduct awareness raising in the area of CDM;

iii. Help in promotion of climate change mitigation activities through CDM in public and private sectors;

iv. Provide technical resources to relevant institutions to develop and implement CDM projects; and

v. Provide Linkages between potential eligible public /private sectors, international consultant firms and investors to promote climate change activities in general and CDM project activities in particular in Pakistan.

Pakistan urgently needs International support for the above as well as for capacity building, and development and transfer of technologies for addressing climate change through the CDM.

9. EDUCATION, COMMUNICATION AND AWARENESS

9.1. Present Status

There is now a growing realization in Pakistan that comprehending climate change issues is not the domain of experts, national planners and policymakers alone, the people in general also need to be educated regarding the impacts of climate change and possible adaptation and mitigation measures. Article 6 of UNFCCC also requires parties to encourage education, training and public awareness programs, within respective capacities and resources. Environmental education is an important priority area for Pakistan and the subject has been dealt with both under the National Conservation Strategy (GoP/IUCN 1993) and the National Environmental Action Plan of the Government of Pakistan (GoP-MoEnv 2003). The MTDF 2005-10 (GoP-PC 2005) envisages to integrate the environment in formal as well as informal education sectors and to raise environmental awareness of the general public, especially in rural areas. It further envisages providing support to research institutions and universities for undertaking need based research in priority environment areas and for organization of scientific conferences / seminars/symposia on environment. Climate Change is an integral part of all such education, research and public awareness activities.

The Ministry of Environment in partnership with key stakeholders is spearheading efforts aimed at incorporating environmental education concepts in school curriculums (GoP-MoEnv 2003). At the same time, both public and private sector institutions have been involved to varying extent in the planning and development of programmes for communicating climate change related information to the intelligentsia as well as the general public and raising their awareness of the critical issues. The effort includes: organization of targeted expert-level workshops around key themes; observing of important international days like Earth Day, World Environment Day, World Water Day,

World Forestry Day etc.; use of electronic media (radio, TV) to convey the message to a larger audience by organizing discussion groups on selected climate change related topics; and use of print media (newspapers and magazines) to disseminate similar information through the publication of both semi-technical and easy-to-understand popular articles etc. However, it is felt, that the ongoing effort is far below the requirements and needs to be expanded very substantially. Also, since various disciplines covering climate change related aspects (e.g. atmospheric physics, atmospheric chemistry, ocean-atmosphere interactions, meteorology, glaciology, modeling of climate system, etc.) are by and large not taught in Pakistani universities, there is an urgent need to develop a corps of climate change professionals / scientists in Pakistan either by getting a group of talented young scientists trained in reputable institutions abroad or by organizing extensive training effort within the country with the help of foreign experts or by a combination of both the above approaches. These professionals / scientists would then serve as trainers for imparting climate change related education and training to other professionals, scientists and teachers working in various organizations and educational institutions.

9.2. Recommended Strategy

In view of the severe lack of critical awareness about climate change related issues at all levels of the society, there is a pressing need to develop and implement a coherent, systematic and sustained communication strategy to facilitate national climate change actions in Pakistan. The overall goal of this strategy should be to contribute effectively towards: (a) enhanced critical effort on adaptation by vulnerable sections to emerging climate change impacts, (b) improved national initiatives for mitigation of climate change, and (c) better informed national level decision making. In order to communicate on the above framework, the following steps may be taken:

- Identify a number of different channels and tools such as print and electronic media, publications, portal website, discussions and advertising, targeted dissemination of briefs, showcasing model practices, specific campaigns etc.;
- Initiate in parallel to the ongoing communication activities. three permanent forums for Media, Civil Society and Policy, each forum comprising 10 to 15 members and acting as lead communication agent in its respective sector, thus multiplying impact with minimum input;
- Undertake two dimensional capacity building for communication by developing on one hand the capacity of key communicators (media, NGOs etc.) in the field of climate change and, on the other, the capacity of policy and scientific organizations as well as change agents, for communicating climate change actions at different levels;
- Ensure that the above development work and the subsequent implementation of communications are undertaken by professionals in a continuous and sustained manner over at least five years. The first task of climate change communication strategy must be a communication needs analysis in line with the above framework and based on a comprehensive, national, statistically significant survey. The next task would be to develop a detailed communication strategy, including precise

target audiences and exact messages. The third task would be to establish a continuous monitoring and periodic evaluation system so that course corrections could be made regularly;

- Implement the strategy in a modular manner by undertaking different sets of activities as separate projects; and
- Financing being a key determinant for the success of climate change communication in Pakistan, ensure to make adequate budget available nationally under which a specific number of communication projects may be designed, implemented, monitored and re-initiated.

10. INSTITUTIONAL CAPACITY FOR ADDRESSING CLIMATE CHANGE

Pakistan has all along been concerned about global climate change phenomenon and has been actively participating in various international forums dealing with the issue. It signed the UNFCCC as early as June 1992 and the Kyoto Protocol in December 1997. Despite the above, the country has been rather slow in taking conscious decisions to address climate change at the national level. That climate change could pose serious threats for Pakistan was first pointed out in the "Pakistan National Conservation Strategy" document (GoP/IUCN 1993). Later on the vulnerability of Pakistan to climate change was reviewed in the ADB (1994) report: "Climate Change in Asia – Regional Study on Global Environmental Issues" and the GoP/UNEP (1998) report "Climate Change and Impact Assessment & Adaptation Strategy for Pakistan". However, it was only in May 2002 that a dedicated research effort for climate change studies was initiated in Pakistan by establishing Global Change Impact Studies Centre with seed money provided by the Ministry of Science & Technology. From July 2003 to September 2009 GCISC was supported by the Pakistan Planning Commission under its Public Sector Development Programme and thereafter by the Ministry of Environment from its development funds. Recently (in January 2010) the Federal Cabinet accorded its approval for the functioning of GCISC as an autonomous research organization under the umbrella of the Ministry of Environment.

10.1. Global Change Impact Studies Centre

The main objectives of GCISC are: (i) to keep a track of the current and likely future trends of climate change, globally and within Pakistan; (ii) to analyze and evaluate their likely impacts on the key socio economic sectors in Pakistan; (iii) to identify how science and technology may be called upon to cope with the adverse impacts, if any, and to advise national planners on the appropriate strategic approaches; (iv) to enhance national capacity for climate change research; and (v) to raise public awareness of climate change related issues.

The current focus of research at GCISC is on: (i) projection of climate changes in Pakistan over the next several decades based on (a) world level coarse resolution projections made by various GCMs, and (b) dynamic downscaling of the outputs of selected GCMs using Regional Climate Models to obtain high resolution projections;

(ii) Assessment of past temporal changes in the Karakoram glaciers using Remote Sensing data from satellites; (iii) Monitoring Assessment of the impacts of projected climate change on (a) glacier melt and water inflows in main rivers of Pakistan, and (b) productivity of various agricultural crops in different climate zones of the country, using respectively Watershed Models and Crop Growth simulation Models; (iv) identification and assessment of appropriate adaptation measures; (v) development of indicators and indices for extreme climate event and development of methodological tools for projecting the occurrence of such events; (vi) Seasonal predictions and climate forecasts at decadal and inter-annual levels; (vii) RS/GIS based studies of temporal changes resulting in deforestation, land degradation, inundation of deltaic region, glacier lakes formation and associated flooding (GLOF); and (viii) assessment of alternative energy supply strategies for Pakistan with focus on GHG mitigation and preservation of local environment.

GCISC has been working in collaboration with various relevant organizations in the country, in particular PMD, WAPDAs, NARC, University of Agriculture in Faisalabad, University of Arid Agriculture in Rawalpindi, SUPARCO etc. The Centre has also been engaged in enhancing the capacity of its scientists as well as those working in other relevant organizations by holding Training Workshops, particularly in the area of simulation modeling.

10.2. Pakistan Meteorological Department

Pakistan Meteorological Department (PMD) is the service and research organization in disciplines related to weather and climate. It has set up more than 70 meteorological data collection stations all over the country extending from several thousand feet above the ground level close to glaciers down to considerable distances off-shore into the sea. Its interest in analysis of past climate trends and projection of future trends dates back to late 1990s; it contributed such information to the UNEP sponsored, Ministry of Environment study: “Climate Change, Impact Assessment and Adaptation Strategies in Pakistan” (GoP/UNEP 1998). Since the establishment of Global Change Impact Studies Centre, PMD has been working in close collaboration with it and has conducted several joint studies. PMD has now enhanced its computing capacity to fast grid computing environment, enabling it to deal with voluminous and multidimensional datasets of fine resolution covering emerging researchable issues of climate change. After carrying out statistical analysis of climate projections on decadal basis using GCM ensemble data, PMD is now proceeding to dynamical downscaling of GCM20 projections in collaboration with other regional partners to produce basin scale scenarios for the South Asia Region. PMD contributes towards monitoring and advanced warning of extreme events such as floods, heavy rain spells and cyclones. It is also engaged in studies on snowmelt runoff modelling and land use change in the context of climate change.

10.3. Other Organizations

While GCISC is the only organization in Pakistan with an exclusively climate change related mandate, there are several other organizations in the country besides PMD whose mandates and activities partly cover climate change related issues and which have either some very relevant climate change related capacities or are pursuing climate change

related projects. In this connection, a useful survey was recently conducted by Oxfam with its results summarised in the Oxfam (2009) report "Climate Change in Pakistan: Stakeholder Mapping and Power Analysis"; these results are reproduced in Annex-J. The listing covers the following organizations and briefly lists for each organization its mandate, climate change related mandate, climate change related capacities/ projects, and influence on climate change policy:

(i) **Federal Ministries**: Ministry of Environment (MoEnv), Planning Commission, Ministry of Water and Power, Ministry of Food & Agriculture, Ministry of Livestock and Dairy Development;
(ii) **Government Funded Organizations**: PMD, GCISC, AEDB, ENERCON, Pak-EPA, NARC /PARC, PCRET, NIO, PCRWR; NDMA and the corresponding provincial and district level organizations;
(iii) **International Organizations**: World Bank (WB), ADB, Donors (DFID, NORAD, SDC), UN Agencies (UNDP, GEF, UNIDO, UNESCO etc.);
(iv) **NGOs**: LEAD-Pakistan, IUCN, SDPI, Oxfam, other small NGOs.

Missed in the above listing are some organizations with useful capacity for addressing climate change related issues, such as those listed below:

Ministry of Foreign Affairs: Specialised capacity in the field of international negotiations on climate change issues;
WAPDA: Capacity in high altitude meteorological data collection, physical mapping of glaciers, round the year measurement of river flows at critical locations, reservoir monitoring and control, watershed modelling and various mitigation activities in the power sector;
SUPARCO: Specialised capacity in RS/GIS for use in monitoring of glacier recession, deforestation, land erosion, coastal area inundation etc.;
PAEC/ PINSTECH: Specialised capacity to measure surface and sub-surface water flows and identify their sources of origin using isotopic techniques; mitigation through the use of nuclear power; development of national GHG inventory;
COMSATS Institute of Information Technology: Capacity to teach and guide post-graduate research in Meteorology and Climatology; capacity for conducting glacier monitoring studies;
Hydrocarbon Development Institute of Pakistan (HDIP): Capacity for development of national GHG inventory and use of CNG as a transportation fuel;
Pakistan Forest Institute: Capacity in large scale afforestation and reforestation;
National University of Computer and Emerging Sciences (FAST): Broad appreciation of climate change related issues in Pakistan with particular emphasis on agriculture, livestock and irrigation water;
Asianics Agro Development International (Asianics): Capacity for assessing climate change impacts on agricultural systems and for finding corresponding solutions;
ICIMOD: Specialised capacity in glacier and snow monitoring, watershed modelling and studies of mountain ecosystems.

Experts from a number of the above organizations have been helping the TFCC either as TFCC members or as members of the various WGs set up by the TFCC. It has come out from these interactions that the number of professionals with relevant capacities in most of the organisations is quite small and generally lacks adequate training. Similarly, the capacities of these organizations to undertake major mitigation and adaptation projects are seriously constrained by the lack of financial resources and non-availability of appropriate advanced technologies. It is therefore recommended that (i) the capacities of all such organizations be adequately enhanced, (ii) climate change related scientific disciplines be introduced in Pakistan's leading universities so as to ensure a regular supply of trained manpower, and (iii) a National Data Bank for climatological, hydrological, agro-meteorological and other climate change related data be established to cater for the needs of all relevant institutions.

Section 11 lists various specific activities and programmes for which technological, capacity building and financial support from international organizations is needed by Pakistan to address the climate change issues.

11. NEEDS FOR INTERNATIONAL COOPERATION

Listed below are some specific activities and programmes for which technological, capacity building and / or financial assistance is needed by Pakistan to address the climate change issue:

11.1. Mitigation Effort

1. Afforestation and reforestation, particularly in the Northern areas, Southern Sindh and Coastal areas;

2. Use of Renewable Energy Technologies (Windmills, Small scale Hydropower, Geothermal Energy, Solar Photovoltaics, Solar Water Heaters, Biogas, Biofuels);

3. Popularization of Efficient Cooking Stoves for use with fuel wood, particularly in the mountainous areas and regions where excessive cutting of trees for fuel wood is causing deforestation;

4. Use of clean coal technologies (e.g. CBMC, CCS, IGCC) so as to allow the use of the country's vast resources of coal without much GHG releases;

5. Infrastructure development (e.g. laying down of pipelines) for large scale import of natural gas, the cleanest of the fossil fuels;

6. Use of advanced nuclear power technology;

7. Effort on Energy Conservation and Energy Efficiency Improvement in various sectors;

8. Reduction of T&D losses in the electricity and gas sectors;

9. Introduction and use of Mass Transit Systems in large cities;

10. Greater use of CNG in the transportation sector;

11. Introduction and use of Electric / Hybrid Vehicles;

12. Large scale use of Waste Heat Recovery and Cogeneration Systems in the industrial sector;

13. Introduction and use of Generation of Electricity from Urban Waste;

14. Increase in Hydropower generation capacity;

15. Use of available bagasse based excess power generation capacity.

11.2. Adaptation Effort

1. Sufficient expansion of large reservoir capacity to ensure water security of the country against large-scale intra-annual and inter-annual fluctuations in rainfall and river flows as well as to help in increasing the hydropower capacity, providing protection against floods and droughts and allowing regulated flow of necessary water in Indus below Kotri to prevent excessive sea water intrusion in the deltaic region;

2. Development of small surface storage on river tributaries and nullahs to prevent silting of major new dams;

3. Lining of canals to reduce seepages of water;

4. Improving efficiency of water supply and distribution in the irrigation system;

5. Local rain harvesting;

6. Effort on enhancement of adaptation capacity in the Agriculture and Livestock sectors to counter negative impacts of climate change. This will involve, inter alia, the following measures:

    - development of new breeds of various crops which are high yielding, heat-stress tolerant, less demanding for water as well as less vulnerable to excessive water in the root zones, and more resistant to diseases and insects;

- development of new breeds of various cattle and livestock which are heat stress and drought tolerant, more productive in terms of meat and milk, and have better reproduction characteristics;

- popularization of the above new varieties of crops and livestock, leading to their large scale adoption by the farming community;

- improvements in the efficiency of use of irrigation water;

- control of the likely increased incidences of insects and pests etc.;

7. Promotion and adoption of more efficient agricultural practices, e.g. laser leveling of fields, trickle irrigation, sprinkler irrigation, zero tillage/ reduced tillage etc.;

8. Improving the quality of rangelands by increasing native rangeland vegetation and planting adapted species, and by proper rangeland management;

9. Development of capacity to deal with natural disasters and extreme weather events like floods, droughts and cyclones, covering both disaster preparedness and disaster management aspects (The disaster preparedness aspect will include establishment of efficient data collection and monitoring systems, communication systems and early warning systems.);

10. Implementation of appropriate protective measures (such as the construction of structures like dikes and seawalls) at strategic points on the coast;

11. Construction of proper engineering works to protect beaches from excessive erosion of beach sediment;

12. Protection of mangrove forests as they provide a natural defence system along the coast;

13. In the long run, if necessary, relocation of communities and infrastructure currently located in highly threatened zones.

11.3. Capacity Building

1. Expansion of meteorological monitoring stations in various parts of the country, in particular in the northern mountainous areas and the glacierised regions feeding IRS and over the Arabian sea adjoining Pakistan's coastline, to the level recommended by the WMO;

2. Active participation in the WMO's new initiative to create Global Framework for Climate Services (GFCS);

3. Development of a cohort of professionals in the field of climate change by sending a viable group of young scientists to reputable institutions abroad for M.S. and Ph.D level studies in the relevant subjects as well as by organizing intensive training activities within the country with the help of foreign experts;

4. Enhancement of capacity:

    - To take necessary measures to become an active participant in the global transition to energy efficient and low Carbon economy.
    - To make reliable projections of climatic changes, seasonal forecasts, inter-annual forecasts of extreme events (droughts and heavy floods) etc. for different parts of Pakistan using the existing climatological models (Global Circulation Models, Regional Climate Models, Mesoscale Models, Models for Seasonal Forecasts, Models for Forecasts of Extreme Events etc.) and by making suitable modifications in them, if necessary, for better representation of Pakistan's climate;
    - To undertake RS/GIS based studies to assess and quantify the past temporal trends and monitor the future changes in snow cover, glacial volume, glacial lake formation and burst, deforestation, land degradation (salinity, waterlogging etc.), soil erosion, inundation of Indus deltaic region and other coastal areas etc.;
    - To monitor the sea level and temperature and cyclonic activity in the Arabian sea; to develop capacity to make predictions for cyclones on the basis of changes in the sea surface temperature and other relevant factors.
    - To make reliable vulnerability assessments for various sectors, in particular Water (e.g. in terms of changes in total and seasonal river flows), Agriculture (e.g. for changes in productivity of various crops and livestock) and Energy (e.g. for secondary /indirect impacts) using Watershed Simulation Models, Crop Growth Simulation Models and other appropriate tools for assessment of climate change impacts on different sectors.
    - To address more effectively the adverse impacts of extreme climate events (floods, droughts, cyclones etc.) by enhancing the capacity of NDMA and related provincial and district organizations.
    - To undertake comprehensive assessment of economic implications of climate change impacts on various sectors and of using different adaptation measures.

5. Development of an institutionalized system of GHG inventory preparation to build both individual and organizational expertise in the country to prepare more accurate and reliable inventory estimates and an inventory database system

6. Strengthening of the national institutional framework for undertaking tasks related to the implementation of UNFCCC. For this (i) GCISC should be

strengthened, provided with necessary financial and technical support, and attached with the Ministry of Environment as an autonomous body to serve as its research arm, and (ii) The existing Climate Change Cell in the Ministry of Environment should also be strengthened and made responsible to coordinate all climate change activities at the Ministry other than research and to ensure that climate change issues are duly addressed in various policies of the Government.

7. Enhancing national capacity for integrating climate change and overall developmental imperatives and ensuring that climate change and socio economic development are pursued as inseparably twin objectives.

8. Enhancing capacity to prepare projects and programs in the climate change area;

9. Raising public awareness and incorporating climate change issues into national formal education systems at all levels in order to facilitate effective implementation of climate change measures;

10. Establishing a national clearing house for information sharing and networking on climate change;

11.4. Regional Collaboration

Regional collaboration is required, inter alia, on the following aspects:

- Monitoring of HKH glaciers and snow cover using Remote Sensing and GIS techniques as well as ground based observations; exchange of available past data and results of analyses;

- Exchange of meteorological data, in particular the data obtained from high altitude monitoring stations;

- Provision of real time data on river flows by upper riparian countries to lower riparian countries;

- Exchange of results from simulation modelling experiments for inter-annual and decadal climatic projections, seasonal forecasts, and predictions of climate extremes in the region; and

- Exchange of data on monitoring of cyclonic activity in the Arabian sea, Indian Ocean and Bay of Bengal.

12. INTERNATIONAL NEGOTIATIONS FOR FUTURE CLIMATE CHANGE REGIME

Pakistan has been an active member of the international community and is a signatory to all the major international agreements on environmental issues. It signed the United

Nations Framework Convention on Climate Change in June 1992 and ratified it in June 1994; it also signed the Kyoto Protocol in December 1997 and ratified it in January 2005. In its capacity as the then Chairman of the Group of 77 and China, Pakistan played a pivotal role in shaping the Bali Plan of Action during the 13th Conference of Parties to UNFCCC held in Bali, Indonesia in December 2007. Pakistan stands firmly committed to the principles and objectives enshrined in various articles of the UNFCCC and the Kyoto Protocol.

Pakistan contributes very little to the overall GHG emissions but remains highly vulnerable to the negative impacts of climate change. As a developing country, Pakistan will not only be adversely affected because it is less able to adapt than the developed countries, but climate change will also confront it with additional challenges of tackling poverty, improving health care, increasing water and food security and improving access to sources to clean sources of energy.

The tenure of the Kyoto Protocol is until 2012. Negotiations to shape the international effort for addressing climate change in the post-Kyoto period are likely to continue for at least one more year as no final agreement could be reached at the United Nations Climate Change Conference held in Copenhagen in December 2009. It is recommended that, in line with its position during the Bali and Copenhagen conferences, Pakistan may continue to take the following stance on various key climate change issues during the course of future deliberations**:**

12.1. Mitigation Effort by Annex 1 Countries

- Pakistan along-side other developing countries should maintain that the major industrialized countries have the responsibility for causing the historical build-up of Greenhouse Gases in the atmosphere and as such they must bear the responsibility of not only cleaning up the atmosphere but also deeply reducing their dangerous emissions to address climate change. Unfortunately, despite the emphasis by Pakistan and all the other developing countries, the developed countries have thus far continued to evade the above calls and have opted to shift the burden of addressing climate change on the developing countries on the pretext, inter alia, that the cost of reducing GHGs in the developing countries will be lower than that in the developed countries.

- Pakistan should clearly point out that any climate change regime, however fair and just it may otherwise be, that does not take into account the historical responsibility of the developed countries and shifts the burden of emission reduction on the developing countries, would substantially retard the economic growth and development of the developing countries like Pakistan, constrain their ability to address poverty alleviation, and impose upon them the burden of adaptation as well.

- Pakistan should therefore call upon the Annex 1 countries to cut their GHG emissions in the range of 40-50% by 2020 and at least 85% by 2050 from the level of their emissions in 1990; as such cuts by the developed countries are necessary if, as per recommendation of AR4 (IPCC 2007), the average global temperature is not to be

allowed to exceed beyond 2 ^{0}C over what prevailed at the beginning of the previous century.

12.2. Mitigation Effort by Pakistan and Other Non-Annex 1 Countries

- Given its extremely low Carbon emission status and high vulnerability to climate change, Pakistan's key priority is Adaptation to climate change as compared to Mitigation. Still, being a responsible member of the international community, Pakistan should be fully committed to contribute to the global effort to mitigate GHGs through vigorous effort on energy efficiency improvement, energy conservation, and promotion of renewable energy and nuclear power to the extent possible within its financial and technological constraints and consistent with the objectives of meeting the basic energy needs of the country's socio-economic development and growing population while ensuring a reasonable level of energy security. For this it will however be necessary that Pakistan's national efforts are supplemented by the availability of additional and predictable enhanced financial and technological resources from the developed countries.

- Pakistan should take the position that the "nationally appropriate mitigation actions by developing country Parties…. in a measurable reportable and verifiable manner", as envisaged in Article 1 (b) (ii) of the Bali Action Plan must not be viewed as anything other than voluntary actions by these countries; they should not involve any penalties, whatsoever, in case there is any shortcoming on their part in the measurement, reporting or verification of the actions taken. Furthermore, these voluntary actions should be limited to undertaking, to the extent economically and practically feasible, such measurable, reportable and verifiable actions as energy conservation measures, effort on efficiency improvements in fuel use and energy transformations, fuel switching from high-Carbon to low-Carbon fuels, increased use of non-Carbon energy sources (renewables, nuclear power) etc., which would lead to reduction in the energy-intensity of the economy and/or reduction in the Carbon-intensity of the national energy system. As such, they should be provided easy access to Carbon-free, Low-Carbon and CO_2 Capture and Storage technologies by the Annex 1 countries.

- Furthermore, Pakistan should point out that, in spite of an aggressive voluntary mitigation effort by most of the developing countries, particularly those at relatively low level of economic development, their overall GHG emissions will still increase as they go through the development process. So will be the case with Pakistan. The country's level of energy consumption is still very low (about one-third the world average on per capita commercial energy basis and one-sixth the world average on per capita electricity basis) and the country is passing through an energy intensive phase of socio-economic development while striving also to meet the basic energy needs of a growing but largely impoverished population (a large fraction of which still relies heavily on the use of fuelwood and agricultural and animal wastes for its cooking, water heating and space heating energy requirements). Pakistan's overall energy consumption is thus bound to increase in the coming decades. At the same time, because of its very limited petroleum resources, it will be forced to use its extensive resources of coal in order to avoid

prohibitively large energy import bills. The only way to check any large increases in the Carbon intensity of Pakistan's energy system will be to provide it with Carbon-free, low-Carbon and clean coal technologies (CBMC, IGCC, CCS) at affordable costs.

- It may be stressed that, while Pakistan remains determined to deal with the climate change issue utilizing its limited resources, it expects the necessary technical and financial support from Annex 1 countries in developing its capacity to respond to the challenge. Pakistan should therefore maintain that its contribution to the global efforts at addressing climate change hinges on the provision of additional financial resources, technology transfer and capacity building.

- Pakistan should firmly oppose any onerous /binding emission reduction obligations on the developing countries in general and itself in particular. Based on the principle of equity**,** it believes that any cap should be on a universal per capita emission level basis and apply equally to both Annex 1 and non-Annex 1 countries.

12.3. Adaptation by Pakistan and Other Non-Annex 1 Countries

- Pakistan should point out that in view of their high vulnerability to adverse impacts of climate change, adaptation is the key priority issue for Pakistan and other developing countries and that for this they need not only capacity building and access to advanced technologies but also financial support for implementing various costly adaptation measures.

- Article 1 (b) (ii) of the Bali Action Plan, makes it conditional for the "nationally appropriate mitigation actions by developing country Parties" being "in a measurable reportable and verifiable manner" subject to being "supported and enabled by technology, financing and capacity building". The estimated costs of adaptation in developing countries vary in the range US$ 10-100 billion annually (World Bank: US$ 10-40 billion annually; UNFCCC: US$ 28-67 billion in 2030; UNDP: US$ 86 billion by 2015; Oxfam International: US$ 50 billion annually; Christian Aid: US$ 100 billion annually (Flam and Skjaerseth, 2008). According to UNDP (2008), the US$ 28–67 billion cost by 2030, as estimated by UNFCCC, will corresponds to only 0.2–0.8% of global investment flows or 0.06-0.21% of projected global GDP in 2030. Pakistan should express its serious concern that the current global funding for adaptation is just a small fraction of what is needed. Pakistan should also urge on all concerned that the post-2012 climate change regime must include realistic targets and commitments for such support by the Annex 1 countries, both individually and collectively.

12.4. Technical Cooperation, Technology Transfer and Capacity Building

- As a first step to provide additional financial resources needed for the adaptation effort in developing countries, Pakistan may recommend that appropriate levies should be imposed on Joint Implementation and Emission Trading in the same spirit as the current practice of 2% levy on the CDM proceeds.

- As Pakistan has a low technological, institutional and financial capacity to address the climate change related issues, it should call upon the Annex 1 countries and various international and regional organizations that they should, in the spirit of Article 4 of the UNFCCC (common but differentiated responsibilities) and Article 1 (b) (ii) of the Bali Action Plan, come forward and fully cooperate with Pakistan by providing the assistance necessary to address the climate change related challenges.

- It should be pointed out that Pakistan has a firm conviction that addressing the issue of climate change sooner rather than later is in the best interest of the global community. Therefore, despite its meager resources, Pakistan continues in its domestic efforts to tackle the issue. However, it strongly feels that the progress made in real and meaningful transfer of technology, provision of financial resources and capacity-building of developing countries has been slow in forthcoming. Pakistan may emphasize that these issues must be tackled without any further delay if the world has to meet the objectives of the Convention.

- Pakistan should stress that it is looking forward to active international cooperation in terms of technology transfer, capacity building and financial support for both mitigation and adaptation activities as well as for enhancing its research and project development capacities to address climate change related issues Briefly, Pakistan needs support for the following:

    - **Mitigation:** For programmes covering afforestation and reforestation; energy efficiency improvements, energy conservation, and reduction of T&D losses in transmission of electricity and gas; renewable energy supplies, and hydro and nuclear power generation; infrastructure development for large scale import of natural gas - the cleanest of the fossil fuels; and clean coal technologies (CBMC, IGCC, CCS etc.) to permit large scale use of its hitherto unutilised extensive resources of coal.

    - **Adaptation:** For addressing the key concerns of water and food security (expansion of reservoir capacity; efficiency improvements in the supply, distribution and use of irrigation water; development of appropriate new crop and livestock breeds etc.); protection of coastal areas and other vulnerable ecosystems; and development of disaster preparedness and management capacity.

    - **Research and Project Development:** For development of a cohort of highly trained professional scientists in important disciplines related to climate change research (e.g. simulation modelling for climate system and its impacts on watersheds and various socio-economic sectors; remote sensing and GIS applications in monitoring of glaciers, coastal areas, deforestation, land degradation etc.); formulation of plans and projects for large scale adaptation activities in various sectors as discussed in the previous sub-Section on Adaptation.

- Pakistan should fully support the establishment of a new financial and technology transfer mechanism financed by the developed countries under the UNFCCC structure, as proposed by the Group of 77 and China.

12.5. Miscellaneous

- Pakistan should firmly reject any linkage between climate change and international trade to the detriment of its extremely low Carbon emission status.

- Pakistan should also call for defining and establishing of scientific criteria for assessing relative vulnerability of different countries to climate change and for ranking them on the basis of their overall vulnerability to climate change.

- In view of the fact that Nuclear Power is a Carbon-free technology which is helping a number of Annex 1 countries in controlling their GHG emissions, Pakistan should insist that it should be approved as an admissible CDM technology.

- Pakistan should support the continuation of Kyoto Protocol with new GHG emission reduction targets for the Annex 1 countries for the post-2012 climate change regime. Even in the case of worst case scenario in which the world community decides for a new international treaty or a legally binding arrangement, Pakistan should endeavour to ensure, in the very least, a continuation of the Clean Development Mechanism and the Adaptation Fund.

- During the negotiations for a post-Kyoto climate change regime, Pakistan should continue to work closely together with the Group of 77 and China to ensure that the future agreement does not impose unnecessary economic burden on the developing countries, assures their energy and food security, and establishes a just and fair climate change regime that is based on the principles of equity and common but differentiated responsibility.

13. MAJOR RECOMMENDATIONS

Salient recommendations of the Task Force, as covered in the preceding Sections, are consolidated and summarised below:

13.1. Mitigation Measures

13.1.1. Energy

- Energy efficiency improvement at all levels in the energy system chain;
- Energy conservation measures and use of energy-efficient devices;
- Rapid development of hydropower resources;
- Large scale use of various renewable energy technologies that are economically viable;
- Expansion of nuclear power programme;
- Acquisition and adoption of clean coal technologies such as CBMC, IGCC and CCS;
- Development of mass transit systems in large cities;
- Greater use of CNG as fuel for urban transportation.

13.1.2. Agriculture and Livestock

Development and adoption of:

- New methods of rice cultivation that have lower methane emissions;
- New methods for reducing Nitrous Oxide releases from agricultural soils;
- New breeds of cattle which are more productive in terms of milk and meat but have lower methane production from enteric fermentation; and
- New economical feeds that reduce methane production activity of cattle besides providing them with better nutrition.

13.1.3. Forestry

- Intensive effort on afforestation and reforestation.

13.2. Adaptation Measures

13.2.1. Water Resources

- Addition of sufficient reservoir capacity on IRS rivers so that even during high flood years no water flows down Kotri in excess of what is necessary for environmental reasons;
- Local rain harvesting;
- Adoption of stringent demand management and efficiency improvement measures in all water-use sectors, particularly in the supply, distribution and use of irrigation water;
- Reuse of marginal quality irrigation effluent.

13.2.2. Agriculture and Livestock

- Development of new breeds of crops of high yield, resistant to heat stress, drought tolerant, less vulnerable to heavy spells of rain, and less prone to insects and pests;
- Improvement of crop productivity per unit of land and per unit of water by increasing the efficiency of various agricultural inputs, in particular the input of irrigation water;
- Improvement of farm practices by adopting modern techniques such as laser land levelling, crop diversification, proper cropping patterns, optimised planting dates etc;
- Development and introduction of better varieties of livestock which would have higher productivity of milk and are less prone to heat stress and more drought tolerant.

13.2.3. Coastal Areas and Indus Deltaic Region

- Provision of regulated flows down Kotri to conform to minimum necessary environmental flows;
- Restoration and protection of mangroves;
- Construction of proper engineering structures (like dikes and seawalls) to protect beaches and other facilities along the coast;
- Development of capacity to deal with natural disasters such as cyclones, floods, etc.

13.2.4. Forests and Other Vulnerable Ecosystems

- Aggressive afforestation and reforestation programmes with plantation suited to the looming climate change;
- Biological control of forest pests by maintaining viable populations of predatory birds and insects through restricted use of chemical insecticide;
- Preservation of rangelands through proper rangeland management;
- Increase of grasslands using appropriate varieties of grass in saline and waterlogged zones to prevent their degradation;
- Assisting genetically impoverished species or those that have important ecosystem functions by providing natural migration corridors as well as assisted migration;
- Use of gene banks, seed banks, zoos and botanical gardens for preserving genetic diversity and conserving species out of their natural environment.

13.3. Organizational Structure to Address Climate Change

- The Prime Minister's Committee on Climate Change may serve as the apex body for policy guidance and overview;
- The Ministry of Environment may be renamed as Ministry of Environment and Climate Change and provided with appropriate organizational infrastructure to reflect the increased importance of climate change in environmental issues;
- Following the approval of the federal cabinet for establishment of GCISC as an autonomous research organization under the Ministry of Environment, GCISC

should now be adequately staffed and financed to serve as an effective research arm of the ministry and undertake high quality climate change related research and modelling pertaining to cross-sectoral topics;
- Steps should be taken by the Ministry of Environment on priority basis to formulate a formal National Climate Change Policy along with a Plan of Action as a follow up of the TFCC Report.

13.4. Clean Development Mechanism (CDM) Activities

- The CDM Cell in the Ministry of Environment should be appropriately strengthened and its capacity built through international support so that full advantage may be taken of the international financing and advanced technologies available through the CDM mechanism.

13.5. Education, Communication and Awareness

- The effort on communicating climate change related information to the intelligentsia as well as the general public and raising their awareness of the critical issues should be substantially expanded; and
- Use should be made of a variety of channels and tools such as print and electronic media, publications, portal website, discussions and advertising, targeted dissemination of briefs, showcasing model practices, specific campaigns, etc. in order to achieve the desired results.

13.6. Institutional Capacity for Addressing Climate Change

- Capacity enhancement of GCISC and all such organizations in the country which could make useful contribution towards addressing climate change.;
- Introduction of climate change related scientific disciplines in Pakistan's leading universities so as to ensure a regular supply of trained manpower, and
- Establishment of a National Data Bank for climatological, hydrological, agro-meteorological and other climate change related data to cater for the needs of all relevant institutions.

13.7. Needs for International Cooperation

The report notes that Pakistan acutely lacks technical capacity and financial resources to address climate change related issues in an effective manner. It identifies and recommends the following salient areas where international cooperation and support is urgently needed:

Mitigation Effort

- Extensive use of renewable energy technologies (windmills, solar cells etc.);
- Introduction and use of Clean Coal Technologies (e.g. CCS, IGCC, CBMC);
- Use of advanced nuclear power technology;
- Introduction and use of Mass Transit Systems in large cities;
- Infrastructure development for large scale import of natural gas;

- Increase in hydropower generation capacity; and
- Large scale afforestation and reforestation activities.

Adaptation Effort

- Sufficient expansion of large reservoir capacity;
- Improving efficiency of water supply and distribution in the irrigation system;
- Development of capacity to deal with disasters like floods, droughts and cyclones;
- Construction of structures like dikes and seawalls at strategic points on the coast.

Capacity Building

- Expansion of meteorological monitoring stations in various parts of the country, in particular in the northern mountainous areas and over the Arabian sea adjoining Pakistan's coastline, to the level recommended by WMO;
- Development of a cohort of professionals in the field of climate change by getting a group of young scientists trained with the help of reputable foreign institutions in fields such as regional climate modelling, watershed modelling and crop growth simulation modelling;
- Forecasting of seasonal and inter-annual climatic changes and extreme events; and
- Monitoring of temporal changes in glacier volumes and land cover using satellite imagery and GIS techniques.

13.8. International Negotiations for Future Climate Change Regime

Salient recommendations of the Task Force regarding Pakistan's position in international negotiations for a post-2012 climate change regime are:

- Global temperature should not be allowed to exceed 2 ^{o}C;
- Strive for the continuation of the Kyoto Protocol;
- Call for deep cuts in GHG emissions by developed countries;
- Avoid any onerous binding GHG emission reduction obligations on Pakistan;
- Insist that, based on the principle of equity, any cap on GHG emissions should be on a universal per capita level basis and apply equally to all countries;
- Project Pakistan as a responsible and constructive member of international community and seek access to advanced Carbon-free and low-Carbon and Clean Coal technologies;
- Emphasize adaptation as a key priority for Pakistan;
- Call to define and establish vulnerability on scientific basis;
- Reject linkage between climate change and international trade;
- Seek substantial increase in international funding for adaptation and call for new financial and technological mechanism;
- Seek approval for nuclear power as an admissible CDM technology;
- Continue to support the position of the G77 and China.

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Annex-A

Planning Commission's Task Force on Climate Change

Terms of Reference

1. To contribute to the formulation of a climate change policy that would assist the Government in pursuing the paramount goal of sustained economic growth by appropriately addressing the challenges posed by the threat of climate change.

2. To identify and recommend appropriate policy measures for ensuring water security of the country through planning and coordinating in-depth studies of the impacts of climate change and the melting of Himalayan glaciers on the Indus River inflows.

3. To formulate appropriate policy guidelines to ensure food security and energy security of the country in the wake of overall warming, the changing temporal and seasonal water picture in Indus River System, and the rise of sea level caused by global warming.

4. To recommend policy measures for promoting large scale Adaptation and Mitigation efforts, including various CDM activities, in various sectors to counter the overall challenge of climate change.

5. To assess the existing institutional capacities in various organizations and recommend measures for their strengthening, as deemed appropriate.

6. To recommend measures for enhancing understanding and awareness of climate change issues among all relevant stakeholders, including the general public.

7. To recommend the establishment of an appropriate over-arching review-and-policymaking body responsible for advising the Govt. of Pakistan for addressing the threat of climate change in all its manifestations on a continuing basis, to carry forward the work done by the Task Force.

Annex-B

Planning Commission's Task Force on Climate Change
(established on 27 Oct., 2008)

COMPOSITION of TFCC

1. Dr. Ishfaq Ahmad, Advisor S & T / Minister of State, Planning Commission **(Chairman)**
2. Mr. Shams-ul-Mulk, Former Chairman of WAPDA **(Co-Chairman)**

Members:

3. Ambassador Shafqat Kakakhel, Former Deputy Executive Director of UNEP
4. Secretary, Ministry of Environment
   (Mr. Khushnood A. Lashari / Mr. Kamran Lashari)
5. Chairman, WAPDA (Mr. Shakil Durrani)
6. Director General, Pakistan Meteorological Department
   (Dr. Qamar-uz-Zaman Chaudhry)
7. Director LEAD Pakistan (Mr. Ali Tauqeer Sheikh)
8. Secretary, Ministry of Industries and Production*
   (Mr. Shahab Khawaja / Mr. Abdul Ghaffar Soomro)
9. Chairman, National Disaster Management Authority**
   (Lt. Gen. ® Farooq Ahmad Khan)
10. Director General, National Institute of Oceanography**
    (Dr. M. M. Rabbani / Dr. Shaukat Hayat)
11. Chief of Research, Pakistan Institute of Development Economics**
    (Dr. Rehana Siddiqui)
12. Dr. Kausar Abdullah Malik, Professor, Faculty of Sciences, Forman Christian College University, Lahore**
13. Executive Director, SDPI, Islamabad***
    (Dr. Abid Qaiyum Sulehri)
14. Head, IUCN, Islamabad****
    (Mr. Mahmood Akhtar Cheema)
15. Member (SAR), SUPARCO*****
    (Mr. Imran Iqbal)
16. Special Assistant to the Prime Minister on Water Resources & Agriculture******
    (Mr. Kamal Majidulla)
17. Regional Coordinator, ICIMOD, Islamabad*******
    (Dr. Inayatullah Chaudhary)
18. Executive Director, GCISC (Member/ Secretary)
    (Dr. Arshad Muhammad Khan)

PLANNING COMMISSION SECRETARIAT

Chief (Environment), Environment Section, Planning Commission
(Dr. Aurangzeb Khan)

*	w.e.f. 08 Nov., 2008	**	w.e.f. 12 Nov., 2008
***	w.e.f. 11 Dec., 2008	****	w.e.f. 29 Jan., 2009
*****	w.e.f. 02 Mar., 2009	******	w.e.f. 06 June, 2009
*******	w.e.f. 17 Aug., 2009		

Annex-C

Planning Commission's Task Force on Climate Change

Working Groups

Sr. No.	Working Group on	Responsibility	Team Leader / Convener
1.	**Climatology**	To cover past and projected trends of Climate Change in Pakistan	Dr. Qamar-uz-Zaman Chaudhry
2.	**Water**	To cover impacts of Climate Change on water resources, river inflows, Indus deltaic region, coastal areas etc.	Mr. Shams-ul-Mulk
3.	**Glaciology**	To cover recent and likely future trends of temporal changes in HKH glaciers and corresponding impacts on IRS flows	Mr. Imran Iqbal
4.	**Agriculture**	To cover impacts of Climate Change on agricultural productivity, food security, fisheries, livestock, forest resources etc.	Dr. Kauser Abdullah Malik
5.	**Energy**	To cover aspects related to energy strategy of Pakistan in the wake of Climate Change concern	Mr. Shakil Durrani
6.	**Economics**	To cover economics of Climate Change in relation to Pakistan	Dr. Rehana Siddiqui
7.	**Communication and Awareness Raising**	To cover Interaction with Society and Media on Climate Change related Issues	Mr. Ali Tauqeer Sheikh
8.	**CDM, International Cooperation and Financial Support**	To cover CDM scope and effort; Possible financial support from GEF, UNEP etc.; What should GOP be doing ?	Mr. Khushnood Akhtar Lashari / Mr. Kamran Lashari
9.	**International Negotiations**	To cover negotiations on UNFCCC, Kyoto Protocol etc	Ambassador Shafqat Kakakhel

Annex-D

Planning Commission's Task Force on Climate Change

Contributing Experts

1. **Dr. M.E. Tusneem,** Member (Food & Agriculture), Planning Commission
2. **Mr. Naseer Ahmad Gillani,** Chief (Water), Planning Commission
3. **Dr. Yahya Ashraf,** Chief (Food & Agriculture), Planning Commission
4. **Mr. Hameed Marwat,** In-charge (Forestry), Planning Commission
5. **Mr. Nawaz Khan,** Specialist (Water Resources), Planning Commission
6. **Dr. Zaigham Habib,** Specialist IWRN, Planning Commission
7. **Dr. Sajjad Rabbani,** Specialist (Livestock, Poultry & Fisheries), Planning Commission
8. **Syed Jamaat Ali Shah,** Indus Water Commissioner
9. **Syed Raghib Abbas Shah,** Member (Water), WAPDA
10. **Mr. S. Wali Waheed,** Director General (Environment), WAPDA
11. **Mr. Inamullah Khan,** Director (Glaciology) Pakistan Snow and Ice Hydrology Project, WAPDA
12. **Mr. Daniyal Hashmi,** Deputy Director, Hydrology & Research Directorate, WAPDA
13. **Dr. Shahid Ahmad,** Member (NRD), Pakistan Agricultural Research Council (PARC)
14. **Dr. Rakhshan Roohi,** Principal Scientific Officer, National Agriculture Research Centre, PARC
15. **Mr. Hilal A. Raza,** Director General, Hydrocarbon Development Institute of Pakistan (HDIP)
16. **Mr. Arif Alauddin,** Chief Executive Officer, Alternative Energy Development Board (AEDB)
17. **Mr. Irfan Afzal Mirza,** Director General (Technical), AEDB
18. **Dr. Parvez Akhter,** Director General, Pakistan Council of Renewable Energy Technologies (PCRET)
19. **Mr. Faridullah Khan,** Managing Director, National Energy Conservation Centre (ENERCON)
20. **Dr. Ghulam Rasul,** Chief Meteorologist, Pakistan Meteorological Department
21. **Mr. Jawed Ali Khan,** Director General (Environment), Ministry of Environment
22. **Mr. Khizar Hayat,** Joint Secretary (International Cooperation), Ministry of Environment

23. **Mr. Syed Zaheer Ahmad Gillani,** NDM MEAS, (International Cooperation), Ministry of Environment
24. **Ms. Neelofur Hafeez,** Deputy Secretary (Climate Change / CDM), Ministry of Environment
25. **Mr. Farrukh Iqbal Khan,** Director (UN-II), Ministry of Foreign Affairs
26. **Maj. ® Iqbal Ahmed,** Additional Secretary (A & I & F), Ministry of Industries & Production
27. **Dr. Aqdas Ali Kazmi,** Chief (WTO), Ministry of Industries & Production
28. **Mr. Hamad Raza,** Coordinator-NLTA, Ministry of Industries & Production
29. **Mr. Shafiq Ahmad,** Director (SPARCENT), SUPARCO
30. **Dr. Pervaiz Amir,** Manager (Technical Assistance), ASIANICS
31. **Dr. Syed Sajidin Hussain,** Head Disaster Risk Management Unit, Food & Agriculture Organization, Islamabad Office
32. **Dr. Syed Shoaib Raza,** Chief Engineer, Pakistan Institute of Engineering and Applied sciences (PIEAS)
33. **Dr. Manzoor Ahmad,** Head, Isotope Application Division, Pakistan Institute of Nuclear Science & Technology (PINSTECH)
34. **Mr. M. Ahmad Saeed,** Principal Expert (Global Change), IUCN Pakistan
35. **Dr. Abdul Majeed,** Expert (Natural Water), IUCN Pakistan
36. **Mr. Saadullah Ayaz,** Climate Change Coordinator, IUCN Pakistan
37. **Mr. Shakil Ramay,** Research Coordinator, SDPI,
38. **Mr. Shakil Ahmad,** Project Associate, SDPI
39. **Dr. Mohsin Iqbal,** Head, Agriculture Section, Global Change impact studies Centre (GCISC)
40. **Mr. Munir Sheikh,** Head, Climatology Section, GCISC
41. **Mr. Ghazanfar Ali,** Head, Water Resources Section, GCISC
42. **Mr. Arif Goheer,** Senior Scientific Officer, GCISC

Annex-E

Some Salient Climate Extreme Events in Pakistan Since 1990

2009 Karachi received 205 mm of rain at Masroor Airbase and 143 mm at Airport on 18 & 19 July. Heaviest rainfall earlier recorded at Karachi Airport was 207 mm on 1st July, 1977. The normal rainfall at Karachi Airport for the periods 1961-1990 and 1971-2000 are respectively 85.5 mm and 66.2 mm.

2007 Record heat wave gripped Pakistan during June, 2007. 48°C temperature was recorded on 9th June at Lahore, a record repeated after 78 years. Earlier it was recorded on 8th June 1929.

2007 Two super cyclones namely Gonu (02A) of Cat-5 and Yemyin (03B) of Cat-1 developed in the Arabian Sea during June, 2007 and hit Makran coast and adjoining countries. The history of the Arabian Sea at least during the previous century shows no such events occurring twice in a month.

2006 In Pakistan, monsoon-related flooding resulted in more than 185 deaths from late July through mid-August 2006. In neighbouring eastern Afghanistan, heavy rainfall generated flooding that claimed at least 35 lives.

2005 Heavy rain caused flooding in parts of Balochistan / NWFP and Afghanistan during March. The flooding hit Balochistan province very adversely. There were more than 30 fatalities in south-western Pakistan.

2005 During June, unusually warm temperatures in the mountainous areas of northern Pakistan accelerated snowmelt and brought extensive flooding along the Kabul, Swat, Kunar and Chitral rivers.

2003 Heavy rain and snow produced flooding during February (around 17th of February) and was responsible for more than 60 deaths in Balochistan province. Flash flooding washed away parts of roads and highways.

2003 At least one million people were affected by seasonal monsoon rains in southern Pakistan. Heavy rains caused 162 deaths with 153 fatalities in the Sindh province.

2003 During early June, a heat wave caused maximum temperature to reach 52°C at Jacobabad on the 5th of June; normal highs in early June are around 44°C.

2001	620 mm rainfall in Islamabad during 10 hours in the month of July (on 23rd of July); it caused flooding in Lai nullah.
1998-2001	History's worst drought gripped southern parts of Pakistan and parts of surrounding countries.
1999	A severe cyclonic storm hit the coastal areas of Pakistan and India and caused catastrophic damages.
1996	640 mm of rain was received by Lahore in August 1996, making it the wettest month for Lahore during the period 1961-2000. Previously the city received 511.7 mm rainfall during August 1976.
1996	437.4 mm rainfall occurred in Lahore during a 3-day period (23-25 August) causing heaviest urban flooding of the city.
1992	Last century's worst flood in Jhelum river in Pakistan.

Source: Various reports of Pakistan Meteorological Department, National Climate Data Centre, USA and World Meteorological Organization

Annex-F

Projected Changes in Temperature and Precipitation in 2080s

Source: GCISC (2009b)

Table F-1: Projected changes in temperature (°C) in 2080s over Pakistan and its Northern and Southern parts for A2 and A1B Scenarios

	Average Temperature Change (°C) in 2080s		
	A2 Scenario		
	Pakistan	**Northern Pakistan**	**Southern Pakistan**
Annual	4.38 ± 0.44	4.67 ± 0.23	4.22 ± 0.18
Summer (JJAS)	4.13 ± 0.26	4.56 ± 0.28	3.90 ± 0.26
Winter (DJFM)	4.47 ± 0.20	4.72 ± 0.24	4.33 ± 0.18
	A1B Scenario		
	Pakistan	**Northern Pakistan**	**Southern Pakistan**
Annual	3.87 ± 0.20	4.12 ± 0.23	3.73 ± 0.18
Summer (JJAS)	3.70 ± 0.23	4.07 ± 0.26	3.50 ± 0.22
Winter (DJFM)	3.92 ± 0.21	4.11 ± 0.24	3.81 ± 0.19

JJAS: June, July, August & September
DJFM: December, January, February & March

Table F-2: Projected changes in precipitation (%) in 2080s over Pakistan and its Northern and Southern parts for A2 and A1B Scenarios

	Average Precipitation Change (%)		
	A2 Scenario		
	Pakistan	**Northern Pakistan**	**Southern Pakistan**
Annual	3.48 ± 5.78	1.13 ± 3.95	4.28 ± 9.46
Summer (JJAS)	12.16 ± 8.91	7.08 ± 8.35	51.07 ± 39.78
Winter (DJFM)	-5.12 ± 4.78	-2.24 ± 4.10	-20.51 ± 9.05
	A1B Scenario		
	Pakistan	**Northern Pakistan**	**Southern Pakistan**
Annual	-0.4 ± 4.36	-0.73 ± 3.08	-0.89 ± 7.91
Summer (JJAS)	3.89 ± 6.89	1.98 ± 5.74	37.6 ± 34.0
Winter (DJFM)	-6.32 ± 3.58	-4.10 ± 3.10	-15.1 ± 7.61

Annex-G

GHG Emissions in Pakistan

Table G-1. Pakistan's National Greenhouse Gas Inventories for 1994 and 2008, by GHG type

GHG Type	1994		2008		Average Annual Growth Rate (1994-2008)
	GHG Emissions ($MtCO_2$ equiv.)	Share in Total GHG	GHG Emissions ($MtCO_2$ equiv.)	Share in Total GHG	
Carbon Dioxide (CO_2)	95.0	52.2 %	166.6	53.9 %	4.1 %
Methane (CH_4)	72.2	39.8 %	111.2	35.9 %	3.1 %
Nitrous Oxide (N_2O)	11.0	6.0 %	28.6	9.2 %	7.1 %
Carbon Monoxide (CO)	1.4	0.8 %	2.0	0.7 %	2.7 %
Non-methane Volatile Organic Compound (NMVOC)	2.1	1.2 %	1.0	0.3 %	-5.2 %
Total GHG	181.7	100 %	309.4	100 %	3.9 %

Source : PAEC-ASAD (2009)

Annex-H

Pakistan's Energy and Electricity Outlook

Table H-1: Energy Demand Projections by Fuel in Pakistan's Energy Security Action Plan (2005 – 2030)

	2005		2010		2030	
	mtoe	**Share (%)**	**mtoe**	**Share (%)**	**mtoe**	**Share (%)**
Total	55.5	100	79.39	100	361.31	100
Oil	16.33	29.4	20.69	26	66. 84	18.5
Natural Gas	28.17	50.8	38.99	49	162.58	45
Coal	4.22	7.6	7.16	9	68.65	19
Hydro	6.13	11.0	11.03	13.9	38.93	10.8
Renewable	0.00	0.0	0.84	1.1	9.20	2.5
Nuclear	0.67	1.2	0.69	0.9	15.11	4.2

Source: GoP-PC (2005, 2007).

Table H-2: Power Generation Capacity Mix in Pakistan's Energy Security Action Plan (2005 – 2030)

	2005		2010		2030	
	MW	**Share (%)**	**MW**	**Share (%)**	**MW**	**Share (%)**
Total	19540	100	27420	100	162590	100
Oil	6400	32.8	6560	23.9	7760	4.8
Natural Gas	5940	30.4	10800	39.4	83760	51.5
Coal	160	0.8	1060	3. 9	19910	12.2
Hydro	6460	33.1	7 720	28.2	32660	20.1
Renewable	180	0.9	880	3.2	9700	6.0
Nuclear	400	2.0	400	1.4	8800	5.4

Source: GoP-PC (2005, 2007).

Table H-3: Primary Energy Mix and Mix of Electricity Generation Sources by Country / Region, 2003-04

	Pakistan	India	China	USA	European Union	World
	Share (%) in Primary Energy Consumption					
Natural Gas	38	4	3	22	24	21
Coal	5	34	61	23	18	25
Oil	23	22	20	41	37	35
Others (Hydel, Nuclear, Biomass, etc.	34	40	16	14	21	19
	Share (%) in Electricity Generation					
Oil	16	5	3	3	4	7
Natural Gas	49	9	1	18	19	20
Coal	0.3	69	78	50	31	40
Nuclear	2	3	2	20	31	16
Hydro	33	13	16	7	10	16
Renewables (excluding Hydro)	0	1	0	2	5	2

Sources of data: IEA/OECD (2006), HDIP (2009).

Table H-4: Energy Utilization Per Unit of $GDP, 2003-04

	MBtu		MBtu
World	13	UK	6
Japan	6	USA	10
Bangladesh	13	Malaysia	24
Indonesia	26	Saudi Arabia	27
India	27	Pakistan	31
China	35	Iran	47

Source: GoP-PC (2005).

Annex-J

Key Actors in Climate Change and DRM

Source: Oxfam (2009)

Name of the organization	Mandate	CC related Mandate	CC related Capacities/Projects	Influence on CC policy
Ministry of Environment (MoE)	Environment, Focal point Multilateral Environment Agreements, Focal point Global Environment Facility (GEF)	Focal point CC UNFCCC; DNA for CDM; Focal Point IPCC.	CDM Cell, (though understaffed); National Communication to UNFCCC CDM Strategy Forestry sequestration projects (through provincial forest depts..	Main actors on CC Policy (both mitigation and adaptation); and influence position, of Pakistan in International negotiations.
Pakistan Meteorological Department (PMD)	Scientific and service entity working under the Ministry of Defense; Meteorological services throughout Pakistan; Weather Forecast and monitoring; Maintains records of historical data on various climatic parameters; Seismology and Geomagnetism.	Focal point World Meteorological Organization (WMO); Strong role in disaster preparedness (early warning systems); Conduct Climate change related research (including modeling) in collaboration with GCISC. Participate in policy dialogue at national and international levels.	Trained staff in modeling based research; weather forecasting, early warning systems (floods, drought, EQ, cyclone etc.). Conduct CC research	Potential Strong role in CC policy dialogues
Planning Commission	Planning Approval of projects (above Rs. 40 million and/or projects with above 25% foreign exchange) *	No specific mandate related CC but the environment section has a focal person, participates in meetings on CC in the MoE. *	Strong senior staff with technical understanding of development. Recently established Task Force under the Planning Commission to guide on CC policy has been formed.	Most important and key player to influence development sector policies Potential strong role including CC sectoral policies in the country.

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* The role of Planning Commission is discussed in detail under Section 7.1 of the main report.

Name of the organization	Mandate	CC related Mandate	CC related Capacities/Projects	Influence on CC policy
Global Change lmpact Studies Centre (GCISC)	Working under the Planning Commission as independent entity. Conducting modeling based research on climate change and its impact on agriculture and water resources. On this basis adaptation strategies will be developed.	The only CC related research centre in Pakistan (core scientific staff)	lmplemented capacity enhancement project on CC modeling as well as other research by core team. Secretariat to PM committee on CC Dr. Ishfaq Chair PC Task Force on CC Secretariat to PC Task Force on CC	Though not part of the Policy decisions, has high influence on CC policy decisions (Through Dr. Ishfaq Ahmad, Chief Coordinator GCISC)
Alternate Energy Development Board (AEDB)	Develop and promote alternate energy (wind, solar, small hydro)	Participates in CC related discussion in the MoE.	Strong capacities/ sections in renewable/ alternate energy; CDM unit in AEDB; Working on alternate renewable energy projects with potential for CDM (but lack staff and capacities for CDM)	Strong role in developing renewable energy policy Potential strong role in policies related to Mitigation to CC
Energy Conservation Centre (ENERCON)	Under the MOE works on energy conservation and efficiency improvement	MD heads CDM committee on energy. Participates in CC related discussion in the MoE.	Strong capacities/ sections in energy conservation/ efficiency (Potential for CDM, but no capacity). lmplemented several projects through GEF related to climate change mitigation.	Strong role in energy conservation policy; Potential strong role in CC mitigation
Pakistan Environmental Protection Agency (Pak-EPA)	Under the MOE develop and implements environmental regulations in the country (with support from provincial EPAs)	The DG heads CDM committee on industrial and waste management projects) Participates in CCrelated discussion in the MoE.	Strong technical capacities (monitors ambient air pollution in major cities and industrial areas).	Potential strong role in policies related to Mitigation to CC.

Name of the organization	Mandate	CC related Mandate	CC related Capacities/Projects	Influence on CC policy
Ministry of Water and Power	Policy and regulations related to water and power.	No CC related capacities (could find a suitable person to meet)	A policy on alternate/renewable energy approved through Cabinet. CDM has been included for CC mitigation in the policy. No significant work on CC mitigation.	Strong role in energy policy decision. Potential strong policy influence in policies related to CC mitigation (energy (alternate/renewable).
Ministry of Food, Agriculture **Ministry of Livestock (recently separated from agriculture)**	Policies and regulations for food and agricultural Deal with matters related to international trade.	Strong technical experts but no focus on climate change related work especially (adaptation) Participates in CC related policy dialogue.	No policy on agriculture developed in general and for CC adaptation in particular. No specific projects directly related to CC for adaptation.	Strong, role in agricultural related policy decisions. Potential strong influence on climate change policy decisions on adaptation for agriculture.
Pakistan Agricultural Research Council (PARC) **National Agriculture Research Centre (NARC)**	Under the Ministry of Food and agriculture, conduct/coordinate research on agriculture at national level (with a large network to coordinate agricultural research in the provinces).	Relevant programmes not geared to integrating CC; No specific programme on climate change adaptation research.	Strong technical experts (CC related adaptation research in bits and pieces). Study of Himalayan Glaciers (mapping GLOFs)in collaboration with ICIMOD; Various projects on drought resistant varieties, introduction of alternate crops, genetic improvements, pest and disease control, water harvesting and modern irrigation techniques that might have relevance to CC adaptation.	Strong players for agricultural related policies but not proactive in influencing agricultural related CC policies. Experts now members of the Planning Commission Task Force on CC.

Name of the organization	Mandate	CC related Mandate	CC related Capacities/Projects	Influence on CC policy
Pakistan Council of Renewable Energy Technology (PCRET)	Under Ministry of Science and Technology, conduct research on renewable energy technology (solar, bio energy etc.)	Research capacities in technology development (has link to Cc mitigation). No specific programme on CC.	Demonstrating solar and bio energy projects on a small scale (Potential for CDM, but no capacity)	Participate in renewable energy policy dialogues, but less influential.
National Institute of Oceanography	Ocean related research	To coordinate with PMD on Early Warning Systems, (Tsunami, Cyclone etc.)	Measuring sea level rise; satellite monitoring (support from SUPARCO) To monitor salt intrusion and loss of land due to sea rise. Initiating research to assess impact of climate change/sea level rise on the coastal region	Research focus, also attend policy meetings on climate change.
Pakistan Council of Research on Water Resources	Research on water Resources in Pakistan	Some technical experts involved in water related projects that has direct relevance to CC adaptation.	Research on water Resources and its relatiohship with CC. Conducting modeling based research on water modeling for CC. Projects on water harvesting, ground water depletion and their causes that has relevance to climate change.	Currently working in isolation, little influence on policy.
World Bank (WB) and Asian Development Bank(ADB)	Main donors for development projects (including infrastructure projects)	CDM Carbon Funds Climate change and Disaster assessments as part of the programme.	CDM projects in hydro WB Capacity building project on CDM ADB study of the impact of climate change (r998) WB study on the impact of climate change on agriculture (planned)	Potential strong policy influence through funding. So far not very active on CC policy.

Name of the organization	Mandate	CC related Mandate	CC related Capacities/Projects	Influence on CC policy
Donors (DFID, NORAD, SDC)	Development Cooperation (including environment)	Climate change/DRM as the strategic priority areas for most donors (both mitigation and adaptation)	DFID institutional capacity assessment study on climate change (through IUCN) funding for TAP led by IUCN; NORAD capacity building project for CDM in industrial sector; SDC focus on CDM projects in forestry sector.	Influencing CC/DRM policies through Diplomatic links, CC information and projects.
UN agencies	Sectoral Development, advocacy, capacity building, facilitation in policy development	CC taken as cross sectoral in various programme DRM as main theme under one UN UNDP focal point For CC	Projects on CC mitigation (FERTS, Wind Energy through GEF); Environment and DRM themes under One UN include climate change as cross cutting; UNDP MDG carbon fund; UNIDO CDM capacity building project through NORAD funding; UNESCO project on developing early warning system for Tsunami; Some UN agencies have established Emergency and rehabilitation Units for Disaster Management.	Playing an important role in influencing CC and DRM policies though projects, information sharing and funding.
LEAD Pakistan	NGO to provide leadership on Sustainable Development Produce Lead fellows (spread all over the country)	CC recently taken up as an integral part of the Lead programme	Building CC team; Research papers on CC issues; Conducted stakeholders awareness raising meetings on CC in provinces; Awarded project on Consultation for second National Communication to UNFCCC; Lead member in the Planning Commission TF on CC.	Strongly influencing CC policy decision through active participation in various forums/ organizing workshops/consultations.

Name of the organization	Mandate	CC related Mandate	CC related Capacities/Projects	Influence on CC policy
IUCN	Conservation of Nature and Natural Resources	An ongoing programme on climate change.	Technical Advisory Panel on Climate Change Scoping study on CC DFID study on CC Participates in global dialogues on CC Member of Planning Commission TF on CC	Strongly influencing CC policy through TAP, information sharing and participation in various forums.
SDPI	Advocacy and research on environment and sustainable development	Plans to establish a team on CC research	Building CC team; Shafqat Kakakhel renowned UNEP member part of SDPI and member of TF. Initiated Youth Network on CC.	Potential influence on CC policy through Shafqat Kakakhel, Technical advisor SDPI.
NDMA/PDMAs/ DDMAs	DRM policies Capacity enhancement including relief and recovery coordination	Focus only on DRM	Capacities being strengthened in NDMA. PDMAs and DDMAs are still to be established.	Strong influence on DRM policy development. Potential significant role in mainstreaming CC in DRM policy.
Other small UNGOs: Oxfam/ Concern Worldwide/ Church World Service (CWS)/World Vision/AKDN/ lslamic Relief/ Save the Children/Action-ed/ Focus/CRS/ RDPI	Community based livelihood recovery and rehabilitation; addressing vulnerabilities, livelihood and poverty issues.	Mainly involved in community based DRR projects including disaster response and recovery. Some focus on community CC adaptation projects on pilot basis (Oxfam, RDPI).	A strong cadre of social workers and community developers trained in community based livelihood and DRM projects).	Less influence in CC related policy decision; May join hands to raise voice of grass root communities and bring community issues upfront for mainstreaming CC and DRR in development policies.

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Source: Oxfam (2009)

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank	mtoe	Million tonnes of oil equivalent
AEDB	Alternate Energy Development Board	MinFA	Ministry of Food and Agriculture
AR4	Fourth Assessment Report of IPCC	MinLDD	Ministry of Livestock and Dairy Development
Bcm	Billion Cubic Meters	NARC	National Agriculture Research Centre
CBMC	Coal Bed Methane Capture	NDMA	National Disaster Management Authority
CCS	CO_2 Capture and Storage	NIO	National Institute of Oceanography
CDM	Clean Development Mechanism	NORAD	Norwegian Agency for Development Cooperation
CER	Certified Emission Reduction	NWFP	North West Frontier Province
CNG	Compressed Natural Gas	OECD	Organization for Economic Cooperation and Development
CO_2	Carbon dioxide	PAEC	Pakistan Atomic Energy Commission
DNA	Designated National Authority	Pak-EPA	Pakistan Environmental Protection Agency
DRM	Disaster Risk Management	PARC	Pakistan Agriculture Research Council
ENERCON	National Energy Conservation Centre	PC	Planning Commission
GCISC	Global Change Impact Studies Centre	TFCC	Task Force on Climate Change
GCM	Global Circulation Models	PCRET	Pakistan Council of Renewable Energy Technologies
GDP	Gross Domestic Product	PCRWR	Pakistan Council for Research in Water Resources
GEF	Global Environment Facility	PDMA	Provincial Disaster Management Authority
GHG	Greenhouse Gases	PFI	Pakistan Forest Institute
GIS	Geographical Information System	PIDE	Pakistan Institute of Development Economics
GLOF	Glacial Lake Outburst Flood	PMCCC	Prime Minister's Committee on Climate Change
GoP	Government of Pakistan	PMD	Pakistan Meteorological Department
GTZ	German Agency for Technical Cooperation	ppm	Parts per million
HKH	Hindu Kush-Karakoram-Himalayas	RCM	Regional Climate Model
IGCC	Integrated coal Gasification - Combined Cycle power generation	RS	Remote Sensing
IPCC	Intergovernmental Panel on Climate Change	SDPI	Sustainable Development Policy Institute
IRS	Indus River System	SUPARCO	Space & Upper Atmosphere Research Commission
IUCN	International Union for Conservation of Nature	T&D	Transmission and Distribution

LEAD	Leadership for Environment and Development	UNDP	United Nations Development Programme
m^3 / y	Cubic Meters per Year	UNEP	United Nations Environmental Programme
maf	Million Acre Feet	UNESCO	United Nations Education, Scientific and Cultural Organization
Mha	Million Hectares	UNFCCC	United Nations Framework Convention on Climate Change
MoEnv	Ministry of Environment	UNIDO	United Nations Industrial Development Organization
MoFAff	Ministry of Foreign Affairs	Vision 2030	Pakistan in the 21st Century - Vision 2030, GoP-PC (2007):
MoInd&P	Ministry of Industries and Production	WAPDA	Water and Power Development Authority
MoST	Ministry of Science & Technology	WG	Working Group
MoW&P	Ministry of Water and Power	WMO	World Meteorological Organisation
MTDF	Medium Term Development Framework (2005-2010), GoP-PC (2005)	WWF	Worldwide Fund for Nature/ World Wildlife Fund